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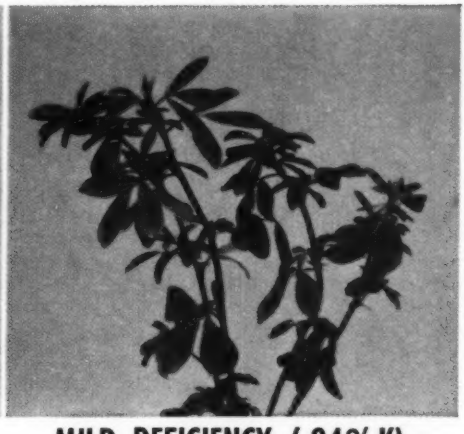
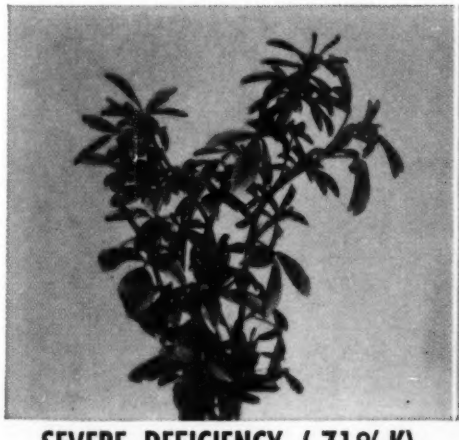
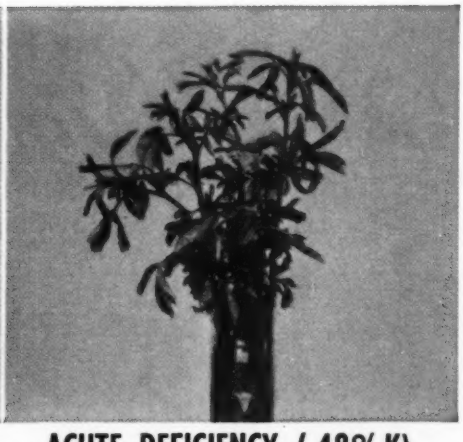
NORMAL (1.5%K)



MILD DEFICIENCY (.94%K)



SEVERE DEFICIENCY (.71%K)



ACUTE DEFICIENCY (.48%K)

((*Turn to page* 31)

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R. H. STINCHFIELD, *Editor*

Editorial Office: 1102 16th Street, N. W., Washington 6, D. C.

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VOL. XXXIX WASHINGTON, D. C., DECEMBER 1955 No. 10

Education sparked from . . .

A Few Live Embers

Jeff McDermid

(ELWOOD R. MCINTYRE)

MUCH ado with good reason marked the century anniversary of the first founding of a land-grant college in America that taught agriculture and the mechanic arts. Visitors to Michigan will never forget the pageantry and progress set alongside the sturdy old milestone institution where so many pioneers blazed trails of learning that culminated in the broad roads to success in better farming and rural living today. But sometimes we overlook an item or two. For example, few pay homage to a man who wrote the preface to the whole agricultural education system.

It was the vision of Elkanah Watson of Pittsfield, Massachusetts, and Albany, New York, that fired the first sparks of imagination in respect to such centers of farm schooling. In 1778-79, Watson made a tour of the eastern lands from Rhode Island to Georgia. In 1780 he set sail for France, taking with him messages from Congress to our ambassador, Benjamin Franklin. After delivering them, Watson remained in Europe as an observer and wide traveler through Belgium, Holland, and England until 1784. There he developed a deep interest in waterways, enhanced by personal trips along the Hudson and Mohawk rivers. In view of his travels and waterway studies, he was named by Governor DeWitt Clinton to the governing body of New York that laid out and supervised the building of parts of the "Grand Canal" which later became the Erie Canal, fraught with so much significance in the days of western settlement.

Watson is best known to present-day farm folks for his zealous efforts over a long period in behalf of county agri-

cultural societies and state boards of agriculture—with their pretentious fairs and farm expositions. His famous Berkshire Agricultural Society is recalled far and wide as the model in its day for progress in rural public affairs.

IT was from many of these societies that the original impetus toward organized education and experimentation in husbandry and the domestic arts sprang into being. One of the earliest of these proposals was printed in a book written by Watson shortly after the year 1800. It reflects some of the current thinking, as Watson was not alone in his championship of education for farm youth. We quote:

"We will suppose a farm containing from 100 to 200 acres of land, in the vicinity of Albany, to belong to the State, under the direction of a board of agriculture and having a variety of soils and a flowing stream. On this farm we will suppose erected suitable buildings to accommodate 100 persons, and several workshops for the construction of farming utensils. Place this establishment under the superintendence of a professor of agriculture, with suitable assistants.

"Here to be deposited plants, shrubs, grain, trees etc., to go under experiments to establish their congeniality to the soils and climate. Here also the best approved instruments of husbandry will be introduced and made. New inventions will be tested, and models of such shall, as they deserve preference, be sent to the county societies. Also, the best plans for rural architects, the best seasons for sowing crops, the most approved fences, and the best kind of domestic animals—all to come within the duties of this important institution. As well as experiments on manures, and the best ways of creating and preserving them. In a word, all that relates to practical husbandry, in connection with chemistry, horticulture, botany, and mineralogy.

"The most useful part of this system will be the education of twenty young men yearly, for one year, from each of the four great political districts of the State, at the expense of the agricultural fund, and to be recommended by the presidents of the county societies. These students to be formed into classes and taught agriculture in all its branches, as well in theory as in practice.

"They must, however, severally engage in labor on said farm as practical farmers at least three hours each day, when so required by the professor, and conform in all respects to the rules and ordinances of said institution. Let it be made the duty of these students to be attached the ensuing year to some respectable academy or school, in their respective districts, under the superintendence of the county societies. In these subordinate schools, let the local youth be furnished with some cheap books on chemistry and the first elements of agriculture, adapted to their capacities, and taught as a branch of their education.

"However desirable the institution of a pattern farm, on a scale commensurate with the importance of the subject, yet it is evident the period of its establishment is remote. Our agricultural societies are in their infancy. They must gradually approach a sufficient state of maturity, to give a tone, and carry conviction to the public mind that such a system will be an important auxiliary to perfecting the science of agriculture, in cooperation with the county societies. When our descendants shall reach that important era, every reflective mind will readily perceive the incalculable benefits of such an institution. *In the progress of time, under the benign operation of this system, the great mass of our citizens will become scientific farmers.*"

SUCH a farsighted man as Watson would be among the first to wish to meet the most famous farmer of his times—President George Washington. Better still, he had a chance to visit the General right out at Mt. Vernon,

south of Alexandria, a beautiful spot high above the smooth Potomac, where we have taken many a pleasant sojourn ourselves. One of its best impressions to the thoughtful visitor is the fact that he is at a country seat probably having the largest list of distinguished guests in the whole United States.

It was therefore the privilege of Mr. Watson to arrive at Mt. Vernon at 2 o'clock on January 23, 1785. He bore letters of introduction from General

Greene and Colonel Fitzgerald. He says that he was a trifle nervous in approaching the home of "the greatest man that ever lived, take him all in all, in any age or country, ancient or modern. Here I found the virtuous Washington reaping the rich fruits of his well-earned laurels, in the quiet shade of his retirement."

Watson continues in such a fine manner that we would deprive the reader of its quality if not directly quoted:

"I found him at table. He received me with the dignity of a prince, and with that urbanity so peculiarly united in the exalted character of a soldier and a private citizen. In my first approach I trembled in awe in the presence of this great man; but he soon put me at ease by unbending in a free and affable manner. That cautious reserve which policy and necessity dictate while he stood at the helm, in raising the thirteen ponderous columns which supported the glorious fabric on which our independence was erected, was the result of his consummate prudence, and not characteristic of his nature. Although I had often seen him in different stages of the revolution, and had the honor to correspond with him from France in 1781, yet this was the first time I had an opportunity to contemplate him in private conversation. I noticed a peculiarity of his smile which seemed to illuminate his eyes, and his whole countenance beamed intelligence at the same time commanding confidence and respect. Here I spent two days as the richest ones of my life.

"His modesty and consummate wisdom induced him to waive every allusion to the late war, in which he acted so glorious and conspicuous a part. His conversation was principally turned to the interior country, and opening the navigation of the Potomac, by locks and canals, at the Seneca great and little falls. His mind appeared absorbed and devoted to this great object in earnest contemplation. He permitted me to take notes from his former journals, estimates, and essays—from which the following are, in part, a short summary:

"Estimated expense—The whole operation is estimated to cost 50,000 pounds sterling, divided into shares of 50 pounds each, or 500 in all. The General supposes the stock will yield 20 per cent income after a few years.

"(In 1803, 23 years after I visited the falls, the canals and locks were completed around the great and little falls, also the Shenandoah and Seneca falls, and considerable improvement made in the river bed; and the navigation of the Shenandoah river was finished at a cost of half a million dollars—with much remaining to be done to complete the navigation to Fort Cumberland, 188 miles above the tidewater. Thus Washington's calculations

(*Turn to page* 51)

Potassium Deficiency of Alfalfa in California

By W. E. Martin, Albert Ulrich, Morton Morse, and D. L. Mikkelsen *

ALFALFA is one of the most important field crops grown in California. In 1954, there were 1,037,000 acres, constituting about one seventh of the irrigated land in the State. Throughout the years, alfalfa has been a heavy user of phosphate. Approximately 12,500 tons available P_2O_5 were used on alfalfa in 1950, or roughly a quarter of the phosphorus supplied on all crops in the State. Very little potassium has been used on alfalfa. In 1950, the figure was only 155 tons of potash expressed as K_2O.

Potash deficiency of alfalfa was first observed and identified in Butte County near Chico in the summer of 1949. Typical white freckling on the margins of terminal leaves occurred in extensive areas, particularly on lands adjacent to potassium-deficient almond orchards. Exploratory rate plots showed clear-cut correction of the symptoms, but only when a thousand or more pounds of potassium sulfate or chloride were applied. Applications of one to two hundred pounds of these materials per acre were virtually ineffective.

Potassium-deficiency symptoms have subsequently been observed and identified throughout the San Joaquin-Sacramento Delta, both on mineral and muck soils.

Alfalfa Nutrient Survey

Purpose of Survey: At the time the potassium deficiency was observed in Butte County, a State-wide survey was begun to determine the nutrient status of typical commercial plantings of alfalfa throughout the State. Plant tissue analysis was used as means of assay. In this method, the actual potassium and phosphorus content of the alfalfa was used as a measure of the nutrient-supplying power of the soil. In this way, it was possible to map out areas deficient in phosphorus and potassium where immediate fertilizer response would seem likely. At the same time, areas and soils high in these nutrients and not needing fertilization could be identified. Similarly, areas low but not yet deficient in phosphorus and potassium could be catalogued for observation. It was hoped that future deficiencies might be anticipated as cropping of relatively new lands continues.

Critical Levels: Greenhouse studies had already been carried out by the Department of Plant Nutrition to determine the "critical levels" of potassium and phosphorus in alfalfa. Plants had been grown in the greenhouse with a wide range of phosphorus and potassium supply. Plant composition associated with acute deficiency and low yields had been established. Similarly, plant composition values which were associated with low, adequate, and high nutrient supply, both of phosphorus and potassium, had been obtained.

Selection of Fields: Typical stands of alfalfa throughout the 32 counties of the State where alfalfa is commercially grown were selected for this study, and the number of samples pro-

* Extension Specialist in Soils; Associate Plant Physiologist; Farm Adviser in Butte County; and Assistant Agronomist respectively. University of California.

TABLE I.—INTERPRETATION OF ALFALFA STEM ANALYSIS

Analysis of middle stems			Value	Response expected from fertilization
PO_4–P p.p.m.*	Total K per cent**	Sulfate test		
Over 2,000	Over 2.5	+	High	None expected
1,000–2,000	1.5 –2.5	+	Adequate	Very unlikely
500–1,000	.75–1.5	−?	Low	Possible but uncertain
Less than 500	Less than .75	−?	Deficient	Response likely

* Soluble phosphate in dried tissue, expressed as parts per million of phosphorus. This is not total phosphorus.
** Total potassium expressed as percentage of dry tissue.

rated on the basis of the reported alfalfa acreage in each county. Seventy-five per cent of the samples were taken from normal fields and the remaining 25% from problem areas where nutritional difficulties were suspected. Alkali spots and areas of high water table were avoided. Where possible, samples were taken adjacent to field fertilizer tests where yield responses to phosphorus or potassium were being observed.

Field Sampling: Alfalfa samples were taken at the time of the usual commercial hay harvest at the second or third cutting. In sampling the fields, areas of 5 to 10 acres on a single soil type were selected and divided into two halves. From each half of the field, 30 entire stems of alfalfa selected at random were cut off at the crown to constitute one of two samples from a field. Greenhouse studies had indicated that the middle stems comprised the most feasible single plant part to serve as the measure of the nutrient status of the plant. Accordingly, after collection, all leaves were removed and the middle stem sample prepared by discarding the upper and lower quarter of the remaining stems. Samples so collected were dried and shipped to Berkeley for analysis.

Analysis and Interpretation of Results: The dried alfalfa stems were ground to pass a 40-mesh sieve and analyzed for total potassium and sodium content and for the amount of phosphate-phosphorus soluble in 2% acetic acid. A qualitative sulfate test was made on the acetic acid extract used for the phosphorus determination. The scale of values used in interpreting the results of the nutrient study is shown in Table I.

Results of Nutrient Survey: The major portion of the alfalfa nutrient survey was conducted during the summers of 1949 and 1950. Additional areas missed in the first two years were sampled in 1952 and 1954. The results of the entire survey may be summarized as in Table II.

TABLE II.—SUMMARY OF RESULTS OF SURVEY

Total number of fields sampled	Percentage of Samples Showing:							
	Phosphorus supply to be				Potassium supply to be			
	Deficient	Low	Adequate	High	Deficient	Low	Adequate	High
646	13.9%	45.0%	38.8%	2.3%	4.6%	28.8%	48.4%	19.0%

The phosphorus data show the status of a crop the fertilization of which is an accepted routine practice in many areas. In 1950, a survey† of fertilizer use indicated that 33% of the alfalfa acreage was fertilized that year. Possibly a larger proportion occasionlly received superphosphate or obtained some phosphorus from barnyard manure. Approximately 14% of the field samples taken appeared deficient in phosphorus and indicated a need of fertilizer. Forty-five per cent showed low value and a reasonable likelihood of response, while the remaining 41% were adequately supplied.

The potassium data represent the potash status of alfalfa in California prior to potassium fertilization. Virtually none of the alfalfa has been fertilized with potassium except as lands may receive farm manures or may follow vegetables which often receive potassium fertilizers. Most of the producing areas were well supplied with potassium. The survey figures indicate that about 67% had an adequate or high supply. Only 5% of the samples showed values low enough to indicate deficiency and likelihood of response to fertilization. The remaining 29% were in the low range, but most of them not dangerously low, and would not be likely to show immediate response to potassium application.

While most California soils are well supplied with potassium, certain few areas are acutely deficient and others show a low supply. The geographic distribution of the potash values is quite revealing. This is shown in the map, Figure 1, and summarized in Table III.

Nearly 80% of the samples from southern California show high or adequate potassium supply. Similarly, the samples from the northeast mountain valleys show 80% adequately supplied. The small number of samples taken from the coastal regions and mountain valleys of the Coast Ranges show over 60% of the fields high or adequately supplied with potassium. In this region, somewhat over a third of the samples are low, but no clear cases of deficiency were observed. In the southern end of the San Joaquin Valley, most of the samples were high or adequate but with a number of low values occurring on the light sandy soils along some of the river courses.

In the central portion of the San Joaquin Valley, particularly in eastern Merced and Stanislaus counties, nearly all of the samples showed low values. Nearly all of these occurred on light sandy soils. A few showed deficient values, but none showed clear-cut potassium symptoms in the field. This

† Carried out by production and Marketing Administration of U.S.D.A.

TABLE III.—GEOGRAPHIC DISTRIBUTION OF POTASSIUM SUPPLY IN ALFALFA

Region	Number of fields sampled	Percentage of middle stem samples showing potassium to be:		
		Deficient	Low	Adequate or high
		Below .75% K	.76–1.5% K	Over 1.5% K
Southern California	155	.....	11.6	88.4
Northeast Mountain Valleys	58	.....	26.1	73.9
Coast & Coast Range Valleys	61	.....	24.6	75.4
San Joaquin Valley	233	3.4	36.5	60.1
Sacramento–San Joaquin Delta Area	52	28.8	48.1	23.1
Sacramento Valley	87	8.0	29.9	62.1

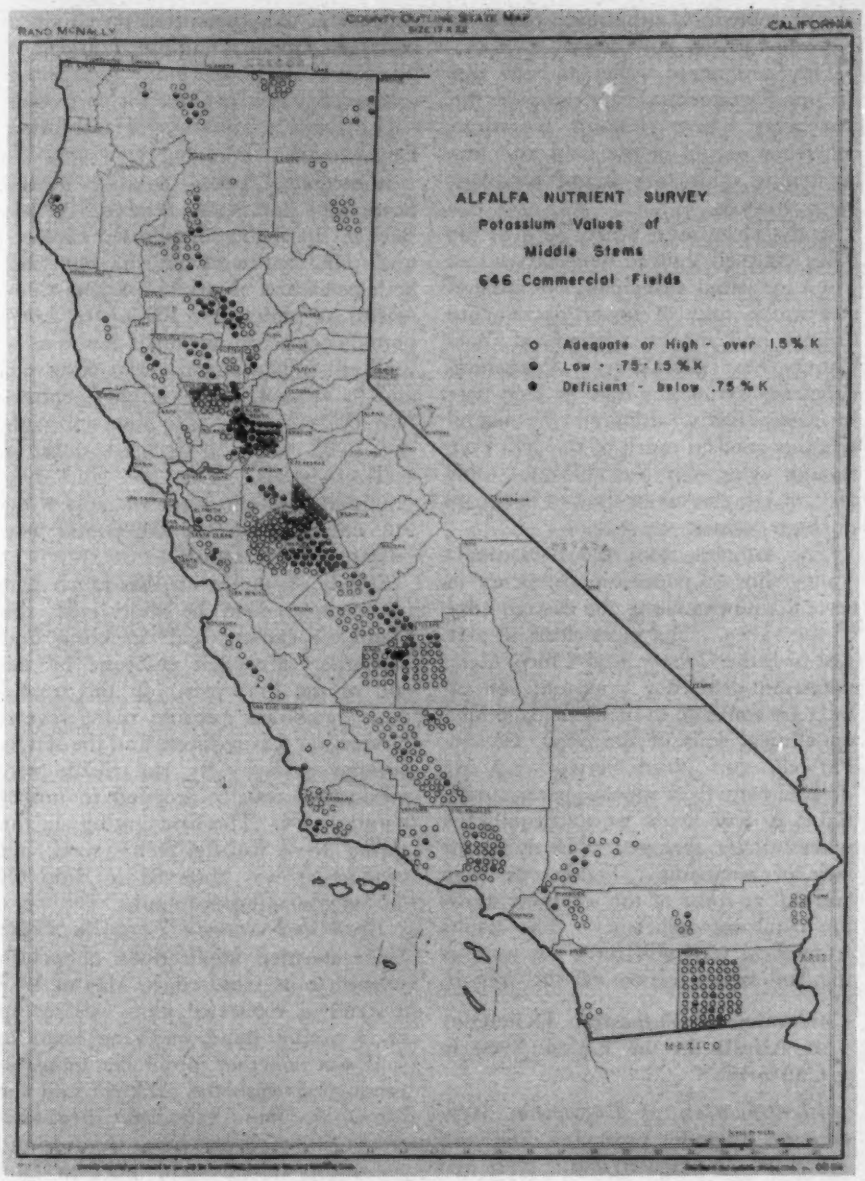

Fig. 1. Alfalfa nutrient survey—distribution of alfalfa potassium values from 646 commercial fields.

area should be watched closely in future years. In contrast, samples taken from the heavier soils on the west side of the San Joaquin Valley showed very high potassium values, reaching as high as 3 to 4% potassium in some stems taken from the Tracy-Patterson area. Some of the deficient values were obtained from fields on the floor of the San Joaquin Valley. These appear to be associated with a high sodium condition resulting from alkali accumulation. Apparently the high sodium on these soils has interfered with the up-

take of potassium, as has been noted on tree crops in the same area.

The Sacramento Valley and the San Joaquin-Sacramento Delta comprise the two areas where clear-cut potassium deficiency occurs in the field and low potassium values are found by plant tissue analysis.

In the Delta area, nearly 30% of the fields sampled showed deficient values. These occurred principally in mineral and muck soils of lower Sacramento County and in the portions of Yolo County near Clarksburg. Potassium-deficiency symptoms may be seen here in many fields, although production remains good in much of the area even though symptoms are evident. Only 20% of samples taken showed adequate or high values.

The samples from the Sacramento Valley showed potassium deficiency in several counties along the eastern edge of the valley. The most clear-cut area was in Butte County, near Chico. Here, potassium-deficiency symptoms on alfalfa are common in many fields located on alluvial soils of the Vina, Conejo, Farwell, and Nord Series. All are derived from basic igneous parent material. A few fields were encountered where alfalfa appeared to be dying for lack of potassium. Field tests were laid out at some of the locations showing potassium deficiency. The results from these tests will form the basis of the following section of this report.

Correction of Potassium Deficiency of Alfalfa in the Chico Area in California *

Identification of Potassium Deficiency: Apparent potassium-deficiency symptoms on irrigated alfalfa were first observed on a second-year stand near Chico on April 21, 1949. These consisted of white speckling on the margins of terminal leaves with complete chlorosis of the leaf developing in severe cases. A nearby almond orchard on the same ranch had shown potassium deficiency. The condition on almonds had been shown to require massive applications of 25 or more pounds of sulfate of potash per tree for correction —(Lilleland University of California Department of Pomology).

Immediately upon tentative identification of potassium deficiency of alfalfa in the field, unreplicated exploratory rate tests were set up, applying both potassium chloride and potassium sulfate at rates from 100 up to 2,000 pounds per acre. Within a few weeks, marked improvement was observed, and by June 2, 1949, complete correction of symptoms was observed with the 1,000- and 2,000-pound rates of both materials. The 100- and 200-pound applications were virtually without effect, while the 500-pound rate gave partial correction.

Stands of alfalfa on this ranch had been observed to be short-lived, the plants developing leaf freckling and becoming somewhat chlorotic by the end of the first year. In the second year, symptoms became more severe, production was reduced, and the stands became grassy. By the third year, production usually dropped to uneconomic levels. The first cuttings in the spring were usually pretty good, but production was observed to drop off during the summer months.

Rate and Source Tests in 1949: Since massive applications of potash seemed to be required, in May of 1949 a series of replicated plots was set up on a young stand on Vina loam to find out whether profitable gains in production could be obtained and the life of the stand extended. Broadcast treatments with potassium chloride and potassium sulfate were made at rates to provide 100 and 500 pounds K_2O per acre from each material. A randomized block design was employed, with all treatments set up in triplicate and material applied in strips 10 x 100 feet. Yields were measured by cutting strips 3 x 100 feet with a garden tractor equipped with a front sickle blade. Harvest was made just prior to the

* Acknowledgment is made of the generous cooperation of Mr. "Rusty" Carter, Mgr., "M & T" Ranch, Chico, Calif.

usual commercial cuttings. The fresh weight of the alfalfa was recorded as measure of the yield. Three cuttings were made during the 1949 season. Carry-over observations were made on the potassium sulfate plots. These comprised a single cutting in the second year (1950) and two cuttings the third season (1951) following the original potassium treatments. Samples for plant tissue analysis were taken at time of harvest to check the uptake of potassium by the plants.

Results of the harvest of these plots are shown in Table IV.

Actually, little potassium deficiency was observed until the September cutting of the first year. Yields at this time were significantly increased by 8 to 10% where 500 pounds of K_2O per acre were applied. Potassium chloride and potassium sulfate gave essentially the same results, indicating that sulfur was not a factor. Analysis of middle stems taken the first season showed substantial uptake of potassium at the higher rates, but the potassium values of the untreated were at or near the

TABLE IV.—RELATION OF RATE AND SOURCE OF POTASSIUM TO YIELD AND COMPOSITION OF ALFALFA

M & T Ranch, Chico, California—Materials Applied May 15, 1949

Yields as pounds fresh weight/acre				Per cent K in middle stems			
Date	Untreated	**Potassium chloride/acre		Date	Untreated	**Potassium chloride/acre	
		170 lbs.	850 lbs.			170 lbs.	850 lbs.
1949				*1949*			
June 9	12,410	13,310	12,700	June 17	.77	.88	1.63
July 7	11,761	11,960	12,468	July 14	.63	.76	1.41
				Aug. 15	.67	.74	1.01
Sept. 20	7,850	8,160	*9,051	Sept. 20	.55	.59	.94
		**Potassium sulfate/acre				**Potassium sulfate/acre	
		200 lbs.	1,000 lbs.			200 lbs.	1,000 lbs.
1949				*1949*			
June 9	12,681	12,690	12,400	June 17	.73	.92	1.59
July 7	12,187	11,635	12,855	July 14	.58	.67	1.12
				Aug. 15	.64	.69	1.17
Sept. 20	8,063	8,402	*8,818	Sept. 20	.56	.56	.87
1950				*1950*			
July 19	8,026	8,301	*9,228	July 7	.56	.54	.71
1951				*1951*			
July 7	10,706	10,996	*11,962	July 9	.51	.60	.71
Aug. 7	8,410	9,039	*9,317				

* Significant increases in yield over untreated.
** Rates of potassium chloride and sulfate to provide 100 and 500 lbs. K_2O/acre.

"critical level" of .76% K. By September, values in the untreated had dropped to around .55% at the time the yield increase had been obtained.

The occasional cuttings and samplings made during the second and third year showed a continued decrease in the potassium values of the plants. Yield increases of 11 to 15% were obtained from the heavy potassium applications. Yields from the light treatments did not differ significantly from the untreated.

Rate and Placement Tests in 1950 and 1951: Because of the high rates of potash required to correct a deficiency, a series of rate and placement tests was set up to determine the most efficient method of applying the material. These tests were established on acutely deficient second-year stands on the same ranch, on soils mapped as Conejo clay loam. Earlier studies by Lilleland (1932) on orchard soils in the Chico area had shown the available potassium supply to decrease with depth. Laboratory studies by Martin, Overstreet, and Hoagland in 1945 had shown some of the soils in the Chico area to fix large amounts of potassium in non-replaceable form.

Accordingly, field tests were designed to compare surface application with corresponding rates of material placed in the sod during the dormant season. A small tractor-operated applicator was employed, placing potassium sulfate 6 to 7 inches deep in slots cut into the sod with coulters set at 18-inch intervals. Tests in 1950 were made comparing 200 versus 1,000 pounds of potassium sulfate per acre. In 1951, 200-, 500-, and 1,000-pound rates were em-

(*Turn to page* 46)

TABLE V.—YIELD AND COMPOSITION OF ALFALFA AS INFLUENCED BY RATE AND METHOD OF POTASSIUM APPLICATION SECOND-YEAR STANDS ACUTELY K DEFICIENT ON CONEJO CLAY LOAM

K_2SO_4 lbs./ac.	Method of application	1950 field plots (3 reps.) 1 cutting—Sept. 7			1951 field plots (2 reps.) 2 cuttings		
		% Potassium*		Yield Green weight	% Potassium* middle stems	Yield green weight lbs./ac.	
		Whole tops	Middle stems	lbs./ac.	July 3	July 3	August 2
None	—	.54	.37	4,961	.35	5,202	4,730
	Tool only	—	—	—	.34	4,880	4,278
200	On surface				.60	6,470	5,800
	In sod	.83	.58	6,740	.69	6,888	7,178
500	On surface				.60	6,924	7,396
	In sod				1.01	7,631	8,193
1000	On surface	1.12	1.03	7,740	.87	8,374	8,410
	In sod	1.61	1.47	7,659	1.49	8,244	8,302
Least Significant difference between treatment means		.15	.31	671	.27	1,405	

* As % of dry weight.

Fig. 1. These fine purebred Southdown ram lambs brought an average of $76 per head. Note how fat they are on pasture alone. They have had no feed and here are grazing Persian clover.

Sheep Production in the South

By Fred J. Hurst

Farm Credit Administration of New Orleans, New Orleans 7, Louisiana

THE United States needs more sheep. Sheep numbers are the lowest in 81 years. There is a national need and a good demand for both high-grade wool and choice market lambs.

Many Southern farmers are adding a small flock of sheep to their farming operations. Sheep not only add to the interest of farming but they increase the net cash income, and help to increase the interest of the young people on the farm.

Farmers find sheep are very little trouble. They help to utilize land not adapted to profitable production of crops and to control weeds. Sheep make more money per dollar invested than any other farm enterprise. In the deep South they are being produced almost largely on pasture with satisfactory returns to growers.

Louie Walton, Superintendent of the Black Belt Experiment Station near State College, Mississippi, grows one sheep for every beef cow on the same land. The sheep eat weeds that cows won't eat and then grass grows where the weeds once grew. And he handles the sheep without any additional labor.

Four years ago Cale Parks of Brooksville, a cotton-dairy farmer, bought 21 ewes and a purebred ram. He sold his first wool clip and 23 lambs for $499. Last year lambs and wool brought him over $600. Mr. Park's sheep are carried almost entirely on pasture. A permanent pasture of white Dutch clover, Dallis grass and lespedeza, Johnson grass meadow, and sweet Sudan grass planted after oats and

clover give year-round grazing. For rotation, he has three fenced pastures. This is good for the sheep and the pastures. Pastures are close to the house so that sheep can be seen most any time.

Tyson Wilson, also of Brooksville, has a flock of 35 ewes and purebred Southdown rams. He has raised sheep for 25 years and says they have never failed to make money. Wool and lambs have brought him $20 per ewe per year. He has fine permanent pastures and grows crimson clover, oats, and red clover for winter grazing.

A Coahoma County, Mississippi, farmer told us that he made more money on his investment and labor in sheep than from his best cotton land. The secret of his success with sheep is his pasture and grazing program. He has four fine pastures which are heavily sodded to Dallis grass, Bermuda grass, white Dutch clover, and lespedeza. Oats are grown for winter grazing and Sudan is planted for supplemental grazing in dry periods during the summer.

On the W. L. Pritchard farm near Inverness we saw a flock of 300 ewes and their lambs grazing on good pasture that was also carrying 100 Angus brood cows. The sheep fit into the pasture program and add to farm income.

One of the State's most successful sheep growers is Howard Green of Canton. He takes pride in producing lambs that bring top market prices during Easter season when the demand for and prices of lambs are usually highest. He not only provides fine permanent pastures but has made a pronounced success in growing crimson clover for grazing.

Under the leadership of the Agricultural Extension Service, Alabama farmers this fall bought 50,000 Western feeder lambs for feeding and for grazing during the fall and winter on small grain and clover. The lambs cost a total of about one-half million dollars, and the growers expect to market them next spring for about a million dollars. Individual farmers throughout Alabama bought from 50 to 1,000 head, depending on size of the farm, available feed and pasture, fencing, and other facilities.

Grazing alone will be used to finish most of the lambs, but where there is not enough good grazing to carry them

Fig. 2. The 300 ewes and their lambs on good pasture are "money makers" on the Pritchard farm near Inverness, Mississippi.

to market weight they will be finished on corn, hay, and protein supplement. The plan is to push them to prime by March or April for shipment to Eastern markets ahead of the regular sales of spring lambs.

Livestock specialists emphasize the importance of "improved" pasture in production of sheep. By improved pastures we mean pastures seeded to adapted grasses and clovers, adequately limed and fertilized, and properly managed. Despite the encouraging progress made in building better pastures in the South during recent years, one has only to drive along rural highways to see on every side poorly seeded, weed-infested pastures which are woefully lacking in lime and the essential plant-food nutrients, phosphorus, nitrogen, and potash.

Both farm research and farm experience have shown the importance of seeding pastures to the approved grasses and clovers such as common Bermuda grass, improved coastal Bermuda, Dallis grass, lespedeza, and white Dutch clover. Most pasture soils are deficient or low in availability of one or more of the nutrients essential for the rapid and profitable production of grasses and legumes.

The Florida Experiment Station has found that "improved pasture grasses are generally much higher in mineral and protein content than the native grasses." The Station reports that "improved pasture grasses and legumes are 3 to 8 times higher in phosphorus and 2 to 8 times higher in calcium than the seasonal average of native grass. The protein content of improved pasture plants is 2 to 7 times higher than that in native grass." The Station authorities then point out that these minerals and protein are very important in normal animal growth.

The South Carolina Experiment Station reminds farmers that "soil fertility is an important factor and a major problem in the growing of good pasture crops. Even though farmers frequently use their most fertile cropland for pastures, most of it is low in fertility and high in acidity. Fields in poverty grass or broomsedge are evidence of low fertility. Many such fields have been converted to productive pasture crops by proper soil treatment."

The Station notes that "requirements

Fig. 3. Howard Green, Canton, Mississippi, left, looks over his fine flock of sheep which are grazing crimson clover.

Fig. 4. C. C. Swayzee of Yazoo county is the "good shepherd" to his fine flock. They know his voice and come when he calls them.

for fertilizer and lime vary widely on different fields and farms, but most land on which pastures are established will require 2 tons of lime and from 500 to 1,000 pounds per acre of a complete fertilizer, such as 3-12-12."

W. R. Thompson, the widely known "Pasture Man" of Misissippi State College, says most growers figure on temporary pasture for sheep from the time the lambs are dropped in the fall until they are sold the next spring. Then the ewes will do well on permanent pasture during the summer. Some growers plant Sudan or millet in late summer.

Thompson says that for late fall and winter grazing the best pasture plants are oats or wheat for the early part of the winter and ryegrass for the late winter. He recommends seeding 100 pounds of small grain or 25 pounds of ryegrass per acre. Apply 60 pounds of nitrogen if the land has been mineralized. If it has not been fertilized, he recommends at least 500 pounds of a high analysis complete fertilizer per acre, topdressed with 30 more pounds of nitrogen after the oats or wheat has been grazed down.

For spring grazing for sheep, Thompson insists that "you cannot beat clover." He likes ryegrass mixed with clover to help control bloat and improve the grazing. White clover is the most widely used, followed by crimson clover. White clover, he advises, should be fertilized with 300 pounds of phosphate and 100 pounds of potash after the land has been limed to a pH of 6.5, if lime is needed.

For permanent pastures of Dallis grass, Bermuda grass, and lespedeza, the regular maintenance rate of 300 pounds of phosphate and 100 pounds of potash applied in the spring is recommended.

The best management for the oats and wheat is to start grazing when the plants are about 6 inches high. The small grain can be grazed until the ryegrass and clover mixture is ready in the spring.

As to rate of stocking, growers should watch the pastures and not graze clover more than 2 inches to the ground.

White clover or crimson clover and ryegrass are ready for grazing when 4 to 6 inches high and should be grazed heavily all during the spring. The clovers and ryegrass will carry the lambs until they are ready for market.

Nitrogen Influences Intake of Other Nutrients by Plants

By E. O. McLean

Agronomy Department, Arkansas Agricultural Experiment Station, Fayetteville, Arkansas

MUCH interest in soil and plant nutrition studies has recently centered around the cation exchange capacity of plant roots. Considerable research has been done on methods of measuring this characteristic of plant roots, on variations in its values with different plant species, and on variations brought about by environmental conditions. The significance of the cation exchange capacity of roots in plant nutrition has been widely discussed.

What is the cation exchange capacity (C.E.C.) of plant roots?

Plant roots have negative charges at or near their surfaces which hold positively charged chemical particles or ions called cations. Soil particles likewise have similar seats of charge. These charge sites attract and hold cations much like small magnets attract iron filings. For this reason roots and soil particles compete for the nutrient cations already in the soil or those added as fertilizer. Plants generate hydrogen ions (cations) in their internal growth processes. These non-nutrient cations may then be exchanged or swapped to the soil for nitrogen (as ammonium), potassium, calcium, magnesium, and to some extent phosphate which are required for growth. The amount of cations in milliequivalents which may be held and exchanged by 100 grams of dry roots is defined as the cation exchange capacity (C.E.C.) This value varies greatly with roots of different crops, but generally those of the grasses and cereals have lower values than those of legumes.

Of what importance is difference in the cation exchange capacity (C.E.C.) of roots in uptake of calcium and potassium?

It is a recognized fact that nutrient requirements for different crops vary greatly. It is also generally accepted that plants differ in their abilities to compete for plant nutrients. Dr. Mack Drake and his co-workers at the Massachusetts Agricultural Experiment Station writing in the May 1952 issue of Better Crops With Plant Food described very clearly the role of the C.E.C. of plant roots in nutrient uptake. They showed that legumes with roots of high C.E.C. take up more calcium while grasses with roots of lower C.E.C. are highly competitive for potassium. Dr. Drake also reported that with certain grass-legume mixtures it was impossible with moderate potash applications to maintain the potassium content of the legume when grown in combination with the grass. Recent studies here and elsewhere suggest that when dealing with plants growing in various soils, the variable abilities of the different soil colloids to compete for the nutrients must not be overlooked in such studies. Otherwise, there are certain to be results obtained which conflict with those of Drake.

Drs. Drake and Steckel [1] have also

[1] See "Solubilization of Soil and Rock Phosphate as Related to Root Cation Exchange Capacity." Soil Sci. Soc. Amer. Proc. 19: In press (1955).

demonstrated that the C.E.C. of plant roots is important in phosphorus uptake. They found that plants with roots of high C.E.C. were more effective in obtaining phosphorus for themselves from soil and from rock phosphate applied to the soil than crops with roots of low C.E.C., and they were two to three times as effective in dissolving soil and rock phosphate for a following crop of sudan. We [2] used a different technique to find that the ability of a crop to utilize phosphorus from relatively insoluble sources is a reflection of properties regulated by the exchange mechanism of the roots. Buckwheat has long been known to be able to utilize the phosphorus in rock phosphate relatively well. It has been found to have a relatively strong tendency to bind calcium to the cation exchange sites of its roots. Alfalfa is somewhat less capable than buckwheat in relative ability to bind calcium and to utilize phosphorus from rock phosphate. Dr. Fried [3] at the Beltsville Station showed that plants differed in their ability to obtain phosphorus from relatively insoluble sources even when the effect of size and extensiveness of the root absorbing surfaces was eliminated as a factor in phosphate absorption. These differences which he observed in the abilities of plants to obtain phosphorus may also be a reflection of the importance in nutrient uptake of cation exchange capacity of the roots.

Is there a relationship between C.E.C. and nitrogen content of roots?

It has been known for some time that age of plant and environmental conditions during the growth period did affect the C.E.C. of plant roots. Yet most of the practical considerations have been based on the assumption that these values were more or less constant and specific for a given crop. Some time ago in one of our studies in which we were determining bonding energies of cations to plant roots we noted that there was some connection between the C.E.C. of roots and their content of nitrogen. We then set up an experiment involving 20 common species of agronomic crops to check this relationship further. We found a relatively high correlation between the C.E.C. of the roots of these crops and the percentage total nitrogen contained in them ($r = 0.844$).

Can the C.E.C. of roots be altered by addition of nitrogen to the plant medium?

This high correlation between exchange mechanism and total nitrogen of roots suggested to us that if the nitrogen content of the roots could be altered by restricting or by enhancing the nitrogen supply in the growth medium, then the C.E.C. of the roots might be altered correspondingly. Studies were undertaken to test this possibility. Plants were grown in gravel cultures bathed with solutions of various nitrogen levels for definite lengths of time. The crops were then harvested, the C.E.C. of the roots determined, and the roots and tops analyzed for total nitrogen. The results obtained are summarized in Table I. Plants grown in low-nitrogen cultures were lower in nitrogen in both tops and roots and (except for vetch) were lower in C.E.C. of the roots than those grown in solutions of medium nitrogen. Plants grown in high-nitrogen systems were higher in nitrogen content and had higher C.E.C. values of the roots than those grown in solutions of medium nitrogen concentration. The legumes, especially vetch, were somewhat erratic probably because they were able to obtain nitrogen from the air. At least nodules were observed on the vetch roots particularly those from the low-nitrogen cultures.

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[2] See "Further Studies Involving Cation Activities in Systems of Plant Roots." Soil Sci. Soc. Amer. Proc. 18:273 (1954).

[3] See "The Feeding Power of Plants for Phosphates." Soil Sci. Soc. Amer. Proc. 17:357 (1953).

Soil Sample Information Sheet Is Important

By William A. Seay

Department of Agronomy, University of Kentucky, Lexington, Kentucky

THE Kentucky Agricultural Experiment Station tests soil for soil acidity, available phosphorus, and available potassium for Kentucky farmers by maintaining 105 county laboratories and a central laboratory in the Agronomy Department at the Experiment Station Building. The county laboratories are supervised by the county agents. The agents supervise the work of the laboratory technicians and make lime and fertlizer recommendations based on the tests. About twice each year, during the period when most county labs were established, a soil-testing school was conducted at the Experiment Station to instruct new technicians. George Corder and Harold Miller, Soils Extension Specialists, now train new technicians in county laboratories and aid with technical problems which arise.

Any person may send samples to the central laboratory but is encouraged to use the one in his county. The central laboratory tests soils for Fayette County in which it is located. Its main function is to be a control and a dispenser of reagents for the county labs. Samples are occasionally sent in by county labs together with test results. The central laboratory also sends out "standard" soils with test results which county technicians can check to see whether their procedure with reagents is good.

The fact that the Kentucky county agent and his county agricultural leaders like the system is seen from the

Fig. 1. Topography influences the nitrogen status of soils. The bottom land by the house will furnish more nitrogen than the steeper slopes across the road or creek.

Fig. 2. Crop residues affect fertilizer requirements. A ton of tobacco stalks like these contain about 30 pounds N, 15 pounds P_2O_5, and 70 pounds K_2O.

increase in numbers of county labs. None has been installed except at the request of the county agent and his county extension leaders. The first lab was placed in Bourbon County in 1948. Today, only 14 out of 120 counties are without labs. Most of those are in mountainous Eastern Kentucky where little testing is done, but even they have arrangements for getting tests made in adjoining counties. In the past five years the number of samples tested has doubled (35,000 to 70,000.)

Soil Sample Information Sheet

A leaflet entitled "How to Take a Good Soil Sample" explains to the farmer the proper procedure for taking

Fig. 3. Past manure applications affect the nitrogen and potassium of the soil. A field receiving frequent manure applications will need less fertilizer nitrogen and potassium.

samples. In addition to taking good samples, farmers are asked to fill out the "Soil Sample Information Sheet." This sheet is divided into three main sections:

A—Farm address and location
B—Soil conditions of samples (topography, texture, etc.)
C—Past fertilizer and cropping history

Often farmers wonder why this information is needed. Many believe that a test of the soil alone is all that is necessary for the county agent to make a good recommendation. The reasons for needing and using the data on the information sheet may be summarized:

1. If the farmer is willing for the county agent to "diagnose the ills" of a soil on the basis of a chemical test alone, he should be willing to have a physician diagnose a pain in his chest without answering the physician's questions. Both the county agent and the physician can do a better job if background information is available in addition to the soil test or the chest examination. The more complete and accurate this information, the better the recommendation or prescription will be.

2. Information on slope, soil type, past manure, and tobacco stalk applications, and past fertilizer and cropping history gives the county agent an estimate of the nitrogen status of the soil.

3. Liming history is necessary in order that lime may not be applied too often.

4. Manure and tobacco stalks to be applied will cut down on the need for commercial fertilizer.

5. Past phosphorus applications should be known in order to help make better phosphorus recommendations.

6. Rock phosphate applications cause a very high test with the method used, but phosphorus may still be needed.

7. All information serves as a check on the chemical results from the sample.

Detailed information concerning these points can be easily understood by persons who do not have technical soils training. County agents and soils workers in Kentucky have found that explanation of the information sheet arouses farmer interest, results in a better response in filling out the sheet, and leaves the "customers" much better satisfied.

Fig. 4. The kind of crop to be grown affects the fertilizer recommendation. Even a soil testing "high" in potassium needs up to 150 pounds of K_2O per acre to grow high quality burley tobacco like this.

Nitrogen Test Not Made

A test for available nitrogen is not used in the Kentucky soil-testing program. Available nitrogen is dependent on soil organic matter and soil microorganism activity and hence fluctuates greatly. Much of the data on the information sheet is used to estimate the nitrogen-supplying power of the soil. Fertilizer nitrogen has nearly all its effect on the immediate crop. Excessive nitrogen causes poor "catches" of grasses and legumes seeded in small grains, causes the grain to lodge, or lowers the quality of burley tobacco. Based on the data from the information sheet, the nitrogen status is estimated as "low" or "medium." Roughly, "low" refers to land that is estimated able to furnish nitrogen for only 30 to 50 bushels of corn per acre and "medium" to land estimated able to furnish nitrogen for 50 to 80 bushels of corn.

Location, Slope, Soil Texture

The farm location, slope of field, and texture of the soil are useful in estimating the nitrogen status of the soil and determining the lime needs. For example, steep slopes are lower in nitrogen than ridgetops or bottoms; sandy soil or heavy clay is lower in nitrogen than a silt loam. Sandy loams need only half as much lime as silt loams, but silty clay loams need about one and one-half times as much. As the county agent is familiar with the soil conditions in the various communities of his county, the farm location tells the agent something about native fertility, drainage, and other factors not recognizable in a small sample.

Crop Residues, Manure Applications

Past manure and crop residue applications give an estimate of the nitrogen status of the soil. If applications of manure and crop residues are to be made, the commercial fertilizer needs will not be as great. A ton of tobacco stalks will supply enough nutrients the first year to take the place of 100 pounds each of ammonium nitrate, superphosphate, and muriate of potash.

Liming History

Liming history helps tell whether lime is needed. A soil may test acid (showing need for lime) and yet may have been liberally limed within the past year. This soil would not need further liming, as the lime applied recently will continue to increase in effectiveness. The laboratory makes an additional check to see whether limestone particles are still present by stirring part of the soil sample with 50% hydrochloric acid. If limestone particles are present, they react with the acid to form carbon dioxide gas causing bubbling or "effervescence."

Fertilizer History

A record of past nitrogen fertilizer applications (in mixed fertilizers or straight goods) helps to give an estimate of the nitrogen status of the soil. This may not be an important factor where only small amounts of nitrogen have been used, but heavy nitrogen fertilization of burley tobacco fields does build up the nitrogen supply of the soil, unless the land is left bare and leaching of nitrogen occurs during the winter.

A history of phosphorus applications (in mixed fertilizers or straight goods) helps tell whether phosphorus is needed. A soil may test low in phosphorus and yet may have had liberal amounts of P_2O_5 applied within the past three years. This soil will not need further application of P_2O_5 for general crops because based on Kentucky research results, 100-200 pounds of P_2O_5 are sufficient for each 3- to 4-year period. Reasons that the soil does not test higher despite phosphorus applications are that the applied phosphorus chemically combines with soil minerals and with iron and aluminum compounds in the soil, and some phosphorus is

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Fig. 1. Trees, the natural vegetation in the humid East, encroach upon pasture lands.

Why More Alfalfa?

*By R. E. Blaser**

Virginia Agricultural Experiment Station, Blacksburg, Virginia

THIS article and one which will follow in another issue were written to assist with successful establishment and maintenance of alfalfa and alfalfa-grass mixtures. Many of the principles set forth also apply to other perennial grasses and legumes. This first article gives reasons for growing more alfalfa while the second article will give specific information on establishing and maintaining this important crop.

Forages Require Special Care

Many people make statements that perennial grasses and legumes grow naturally in this Eastern humid region of the United States. This is not true, as all forage grasses-legume mixtures are artificial plant associations because the yields and stand maintenance are dependent upon man's care.

Forests make up the natural plant populations in this region, Fig. 1. On farms where good agronomic cultural practices are not used, grasslands revert to forests. Different kinds of forest plants are so well adapted that trees finally subdue grasses, legumes, and other vegetation provided man does not interfere by using grazing animals, fertilizers, mowers, or tillage. Success with perennial grasses and legumes depends upon man's interference with nature and his knowledge of cultural practices that will encourage useful grasses and legumes and at the same time retard undesirable plants.

History of Perennial Grasses and Legumes

Improved perennial grass-legume pastures and meadows in the humid East-

* This research was partially financed by the "Old Dominion Foundation."

ern United States are invariably made up of introduced plants. Historically, there is good evidence to support the idea that almost all of the biennial and perennial grasses and legumes used for pasture, silage, and hay purposes in Virginia were introduced from abroad. The clovers (red, white, ladino, and alsike) and perennial grasses like timothy, bluegrass, ryegrass, and orchard grass were introduced throughout the Eastern United States either accidentally or intentionally. The early settlers and agricultural workers found that these and other perennial forage plants were quite well adapted to the climate and leached, acid soil conditions in the humid East. The natural infertile soil conditions in humid regions are attributed to leaching of calcium, magnesium, potassium, nitrogen, and other elements, because of the high rainfall. Seeds of the forage plants that survived under the Eastern soil conditions spread Westward. However, this Westward migration of grasses and legumes was halted by the low rainfall in the Midwest as these Eastern forage plants were shallow-rooted and were not tolerant of long periods of low rainfall commonly experienced in the Midwest and West.

Alfalfa was first successfully grown in the United States in California, and from there it migrated Eastward. Successful alfalfa seedings made in Midwestern States also encouraged its use and spread to Eastern United States. Historically, alfalfa was first used in the lower rainfall regions of the West, because it was adapted to the soils which were high in minerals like calcium, potassium, magnesium, and phosphorus. The natural non-acid and fertile soils, characteristic of lower rainfall areas in the West and Midwest areas, favored alfalfa production in that region. The deep-rooted characteristics of alfalfa also made it more tolerant than other forage legumes of the prolonged low rainfall periods that are common in most Midwest and Western regions of the United States.

New Outlook in Virginia

In Virginia, alfalfa has been growing successfully on certain limestone soils for many years. Farmers have selected favorite soil areas for alfalfa and made liberal applications of lime, manure, and fertilizer. The alfalfa crop was sown in pure stands and used solely for hay. These fields of alfalfa were allowed to remain in production as long as satisfactory yields were obtained. The early plantings often maintained high production and good stands of alfalfa for 10 to 15 years.

The new outlook for alfalfa points to a rapid increase in acreage, Fig. 2. In

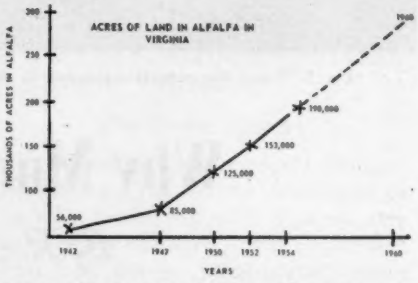

Fig. 2. The land in alfalfa in Virginia has increased from 56,000 acres in 1942 to 190,000 in 1954. Since 1947 there has been a sharp increase in land sown to alfalfa. If the trend since 1947 continues, there will be 280,000 acres of alfalfa by 1960.

1942, there were 56,000 acres of alfalfa in Virginia as compared with only 85,000 acres in 1947. During this five-year period (1942-1947) the annual increase in land sown to alfalfa averaged only 5,800 acres per year. Now let us consider the period from 1950 through 1954. During this four-year period the land sown to alfalfa increased from 125,000 to 190,000 acres, which is an increase of over 16,000 acres per year. If this present trend continues, alfalfa acreage in Virginia will expand to almost a third of a million acres by 1960. The rapid expansion of land sown to alfalfa since 1950 is an indication that Virginia farmers are learning that alfalfa should have a more prominent place in their grassland programs.

Fig. 3. Alfalfa was compared with other legumes in mixtures in this experiment at Blacksburg.

Our experiments and observations show that land sown to alfalfa should continue to increase for the following reasons: (1) It is not difficult to establish and maintain alfalfa; (2) alfalfa is more productive than other forage legumes; (3) alfalfa lives longer than other legumes; (4) alfalfa may be grown alone or in mixtures; (5) alfalfa may be used for silage, hay, and grazing; and (6) alfalfa is suitable for long and short rotations. Instead of considering alfalfa a "hard" crop to grow, farmers are using new research information that points out that it is not difficult to establish and maintain alfalfa.

Production With Other Legumes Compared

The legumes commonly used for pasture and forage in Virginia are white, ladino, red, hop, and alsike clovers, Korean lespedeza, alfalfa, a low acreage of perennial lespedeza, and a very low acreage of birdsfoot trefoil and kudzu. Many of these legumes have been grown in mixtures in experiments established at Blacksburg and Middleburg to measure the forage yield and longevity of legumes in legume-grass mixtures, Fig. 3. In these experiments the lime and fertilizer applications were constant. In general, the soil was limed to pH 6.5 or higher and 1,000 pounds of a 2-12-12 fertilizer with borax were used for establishing the mixtures. Fertilizer maintenance treatments averaged about 600 pounds per acre of an 0-14-14 fertilizer with borax. Cutting treatments that favored a specific legume-grass mixture were used. For example, alfalfa mixtures were cut four times a year whereas ladino clover mixtures were usually cut six times a year.

The yields from different legumes grown with grasses at the Northern Virginia Pasture Research Station at Middleburg are shown in Fig. 4. When grown with orchard grass, the yields during a two-year period (1953-1954) were as follows: Alfalfa—4.22, ladino clover—2.68, red clover—1.96, and Korean lespedeza 1.81 tons of hay per acre. In this same experiment, two legumes grown with bluegrass produced herbage yields as follows: White clover —1.92 and birdsfoot trefoil 1.86 tons per acre.

In another experiment at Blacksburg, grass-legume mixtures produced the following yields during a four-year period: Alfalfa-orchard grass—4.81 tons, ladino clover-orchard grass—1.86 tons, ladino

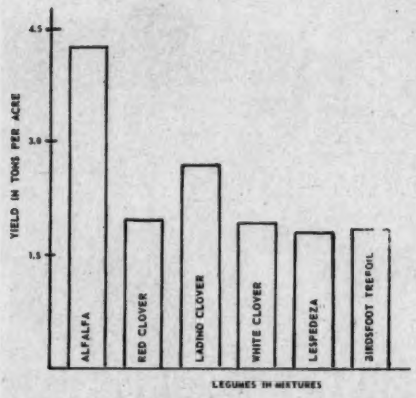

Fig. 4. At the Northern Virginia Pasture Research Station alfalfa mixtures produced higher yields than other grass-legume mixtures. Orchard grass was used with all legumes except white clover and birdsfoot trefoil, where bluegrass was used. The experiment was established in August 1952, and the yield data are average values in tons per acre per year for 1953 and 1954.

clover-Kentucky 31 fescue—1.71 tons, and 1.84 tons of herbage for a bluegrass-white clover-birdsfoot trefoil mixture, Fig. 5. Mixture experiments are also being carried on at six other research stations in Virginia. At five of the research stations where soils are well-drained, alfalfa mixtures produced higher yields than other legume-grass

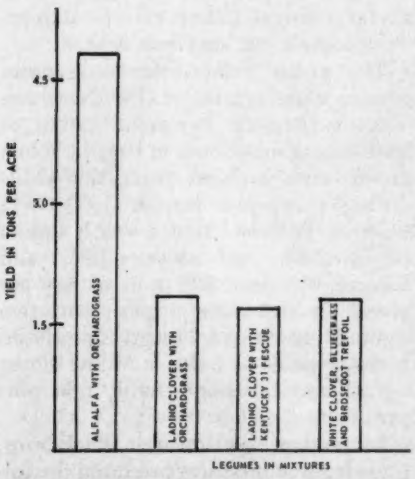

Fig. 5. During a four-year period, alfalfa-grass mixtures were more productive than other grass-legume mixtures. The experiment was established at Blacksburg in August 1950, and the yields are averages of 15% moisture herbage.

mixtures. At one location with poor soil drainage, alfalfa stands and growth were poor as compared with those of other legumes.

Alfalfa was more productive than other legumes during low as well as high rainfall periods. Alfalfa mixtures, where irrigated, generally produced higher yields than other legume-grass mixtures. During low rainfall periods, alfalfa mixtures were much more productive than mixtures with other legumes. The water requirements for making a pound of hay alfalfa and other legumes are similar, ranging from about 500 to 750 pounds in spring and around 750 and 1,200 pounds during summer. The deep taproots of alfalfa increase the available soil moisture, thus hay yields of alfalfa or alfalfa-grass mixtures are higher when compared with other legumes. The comparative growths of an alfalfa-orchard grass and a ladino clover-tall fescue mixture during dry summer weather at Warsaw are shown in Fig. 6.

Part of the high productive capacity of alfalfa, as compared with other legumes, is attributed to its habit of growth and the cutting management. A tall-growing, stemmy hay plant, such as alfalfa that is cut 3 to 5 times a year, will produce more dry matter per acre than leafy plants like white clover or grasses that are cut or grazed more frequently. It should be admitted that alfalfa is not as good a quality forage as grass-legume mixtures that are cut or grazed more frequently.

Stand Maintenance of Legumes

The high yields of alfalfa as compared with other legumes, Figs. 4 and 5, are also attributed to the better maintenance of alfalfa stands. Our experiments and observations during the last five years show that alfalfa has a longer productive life than any other legume in Virginia.

Kenland and other varieties of red clover have been reported to behave as

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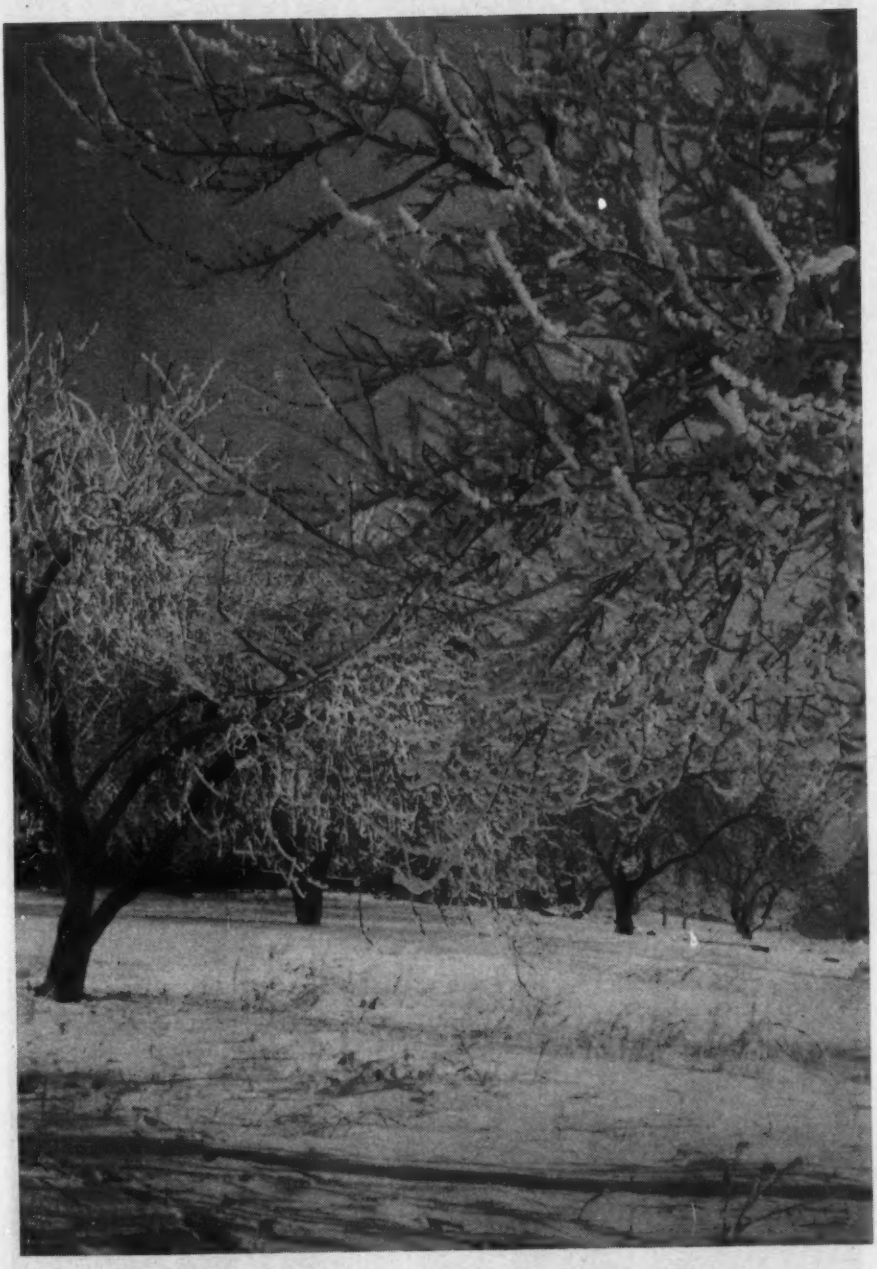
PICTORIAL



Christmas Decorations—*by Nature*

Above: Out for exercise after barn feeding.

Below: Enjoying feed served cafeteria style.

Above: Kept healthy and sleek on a good pasture.

Below: Tided over by pellet form emergency feed.

Above: Rosemary Reed, Queen of the 1955 Muck Crop Show, with Roscoe Fraser, Purdue University's Muck Crop Specialist.

Below: Dwight Cottingham, Indianapolis Agricultural Teacher, and his winning vegetable judging team.

The Editors Talk

The Year Ends

With another year drawing to a close, American agriculture is again taking stock. Surveys will differ in tone, as influenced by the emphasis placed upon various phases of the industry. It cannot be expected, any more than in any other industry, that all segments have fared equally. However, despite the slump in farm prices, the vagaries of Nature, and other deterrent factors, economists and observers are finding the farmer much better off than the bare statistics would indicate.

Total production of crops and livestock apparently will equal or exceed all previous records. This has surprised many agricultural analysts who expected that the decreases in acreage would result in corresponding decreases in production. Farmers, however, have put to good use what they have been told and taught about the application of improved methods of production and have come up with some astonishing results. According to the Federal Reserve Board the general financial position of farmers remains relatively strong.

To strengthen this view, the U. S. Department of Agriculture in its November 28 release on the 33rd Annual Agriculture Outlook Conference held in Washington expects over-all farming costs in 1956 to average about the same as costs in 1955. While tractors, farm machinery, and some building and fencing materials will average somewhat higher, fertilizer costs per pound are expected to remain at about 1955 levels, with some slight decline possible. Fertilizer cost rates have been dropping since 1952. Seed prices and prices of feed are expected to be somewhat lower, and feeder and replacement livestock are likely to cost about the same in 1956 as in 1955.

General comments on cost trends and their relation to farmers' plans for use of production resources (land, labor, buildings and equipment, industrial goods) included: The increasing size of farms and increased use of machinery have made it possible for farmers to be more productive and have reduced labor requirements in agriculture. Depreciation costs on land and machinery have been almost equal to total expenditures for these items during the past two years. Technological advances in use of fertilizers and pesticides have fostered increased buying of these industrially produced goods, and for most farmers they have, of course, been profitable purchases.

Our Cover Picture

Alfalfa is the most extensively grown leguminous forage crop in the 11 Western States. It occupies somewhat more than 5 million of the 40 million acres in crops in these States.

In California alfalfa acreage is now well over the 1-million-acre mark. The crop is produced mostly under irrigation, and the average yield has been about 4½ tons of hay per acre. Fertilizer use has been largely confined to phosphate

and sulfur applications. Although alfalfa is a heavy user of potash, and California's annual crop of about 4,800,000 tons has been removing some 108,000 tons of actual potash (K_2O) from the soil each year, practically no potash fertilizer has been applied.

Our cover page this month, taken in California, pictures stages of potash deficiency on alfalfa with potassium contents of the respective plants. Easily recognized are the first signs of potash starvation, which appear as numerous small white or yellowish dots around the outer edges of the tips of leaflets. As the deficiency continues, these edges begin to turn yellow and the chlorosis proceeds around the entire margin. The severity of marginal yellowing increases progressively from the top of the shoot downward to the older lower leaves. In instances of severe deficiency, the symptoms of marginal yellowing may be much more pronounced than the spotting. This is explained in the book "Hunger Signs in Crops" by the fact that potassium moves very readily within the plant. Under conditions of deficiency, the potassium moves from the lower leaves toward the top of the plant. This accounts for the more pronounced symptoms on the lower leaves.

The article by W. E. Martin, Albert Ulrich, Morton Morse, and D. L. Mikkelsen in this issue describes the first program of experimental work with potash on alfalfa carried on in California. It is apparent from this work that there is, in addition to soil analysis, a valuable measure of the potassium status of alfalfa through the use of plant analysis. Potassium nutrition of the alfalfa acreage in the State can now be more easily watched and appraised by this diagnostic method. It is logical to expect that more potash-deficient alfalfa areas will now be recognized, and that the use of potash fertilizer in these areas will contribute to healthier and more productive stands.

Season Average Prices Received by Farmers for Specified Commodities *

Crop Year	Cotton Cents per lb. Aug.-July	Tobacco Cents per lb.	Potatoes Cents per bu. July-June	Sweet Potatoes Cents per bu. July-June	Corn Cents per bu. Oct.-Sept.	Wheat Cents per bu. July-June	Hay [1] Dollars per ton July-June	Cottonseed Dollars per ton July-June	Truck Crops ....
Av. Aug. 1909–July 1914....	12.4	10.0	69.7	87.8	64.2	88.4	11.87	22.55	....
1929.....	16.8	18.3	131.6	117.1	79.9	103.6	10.90	30.92	....
1930.....	9.5	12.8	91.2	108.1	59.8	67.1	11.06	22.04	....
1931.....	5.7	8.2	46.0	72.6	32.0	39.0	8.69	8.97	....
1932.....	6.5	10.5	38.0	54.2	31.9	28.2	6.20	10.33	....
1933.....	10.2	13.0	82.4	69.4	52.2	74.4	8.09	12.88	....
1934.....	12.4	21.3	44.6	79.8	81.5	84.8	13.20	33.00	....
1935.....	11.1	18.4	59.3	70.3	65.5	83.2	7.52	30.54	....
1936.....	12.4	23.6	114.2	92.9	104.4	102.5	11.20	33.36	....
1937.....	8.4	20.4	52.9	78.0	51.8	96.2	8.74	19.51	....
1938.....	8.6	19.6	55.7	69.8	48.6	56.2	6.78	21.79	....
1939.....	9.1	15.4	69.7	73.4	56.8	69.1	7.94	21.17	....
1940.....	9.9	16.0	54.1	85.4	61.8	68.2	7.59	21.73	....
1941.....	17.0	26.4	80.8	92.2	75.1	94.4	9.70	47.65	....
1942.....	19.0	36.9	117.0	118.0	91.7	110.0	10.80	45.61	....
1943.....	19.9	40.5	131.0	206.0	112.0	136.0	14.80	52.10	....
1944.....	20.7	42.0	150.0	190.0	109.0	141.0	16.50	52.70	....
1945.....	22.5	36.6	143.0	204.0	127.0	150.0	15.10	51.10	....
1946.....	32.6	38.2	124.0	218.0	156.0	191.0	16.70	72.00	....
1947.....	31.9	38.0	162.0	217.0	216.0	229.0	17.60	85.90	....
1948.....	30.4	48.2	155.0	222.0	129.0	200.0	18.45	67.20	....
1949.....	28.6	45.9	128.0	214.0	124.0	188.0	16.50	43.40	....
1950.....	40.1	51.7	91.7	173.0	153.0	200.0	16.70	86.50	....
1951.....	37.9	51.1	163.0	304.0	166.0	211.0	19.50	69.30	....
1952.....	34.6	49.9	198.0	338.0	153.0	209.0	19.95	69.60	....
1953.....	32.3	52.2	79.7	251.0	148.0	204.0	17.45	52.60	....
1954									
November...	33.17	52.0	109.0	216.0	137.0	212.0	18.15	59.40	....
December....	32.67	50.0	105.0	254.0	139.0	212.0	18.55	59.60	....
1955									
January.....	32.51	42.4	113.0	283.0	140.0	214.0	18.75	56.80	....
February....	31.69	36.8	117.0	297.0	140.0	213.0	18.55	55.20	....
March.....	31.87	....	118.0	310.0	136.0	212.0	18.25	53.40	....
April.....	31.93	....	217.0	315.0	136.0	209.0	17.65	53.40	....
May.....	31.51	46.0	223.0	315.0	140.0	213.0	17.45	53.10	....
June.....	31.43	39.5	121.0	392.0	140.0	206.0	16.35	52.00	....
July.....	32.11	38.0	88.0	279.0	140.0	197.0	15.25	54.00	....
August.....	32.74	50.6	75.2	179.0	130.0	190.0	15.25	50.10	....
September...	33.77	51.5	71.3	142.0	124.0	192.0	15.55	43.70	....
October.....	32.83	55.0	72.3	144.0	114.0	194.0	15.75	43.50	....
Index Numbers (Aug. 1909—July 1914 = 100)									
1929.....	135	183	189	133	124	117	92	137	137
1930.....	77	128	131	123	93	76	93	98	128
1931.....	46	82	66	83	50	44	73	40	107
1932.....	52	105	55	62	50	43	52	46	100
1933.....	82	130	118	79	81	84	68	57	90
1934.....	100	213	64	91	127	96	111	146	94
1935.....	90	184	85	80	102	94	63	135	116
1936.....	100	236	164	106	163	116	94	148	108
1937.....	68	204	76	89	81	109	74	87	114
1938.....	69	196	80	79	76	64	57	97	96
1939.....	73	154	100	84	88	78	67	94	98
1940.....	80	160	78	97	96	77	64	96	122
1941.....	137	264	116	105	117	107	82	211	138
1942.....	153	369	168	134	143	124	91	202	178
1943.....	160	405	188	235	174	154	125	231	270
1944.....	167	420	214	216	170	160	139	234	236
1945.....	181	366	205	232	198	170	127	227	240
1946.....	263	382	178	248	212	209	141	319	217
1947.....	257	380	232	248	336	259	148	381	262
1948.....	245	482	222	253	201	226	155	298	253
1949.....	231	459	184	244	193	213	139	192	232
1950.....	323	517	132	197	238	226	141	384	211
1951.....	306	512	233	346	259	239	164	307	269
1952.....	279	499	284	385	238	236	168	309	274
1953.....	260	522	114	286	231	231	147	233	240
1954									
November...	268	520	156	246	213	240	153	263	237
December....	263	500	151	289	217	240	156	264	216
1955									
January.....	262	424	162	322	218	242	158	252	263
February....	256	368	168	338	218	241	156	245	258
March.....	257	...	169	353	212	240	154	237	262
April.....	258	...	311	359	212	236	149	237	270
May.....	154	460	320	359	218	241	147	235	308
June.....	253	395	174	435	218	233	138	231	230
July.....	259	380	126	318	218	223	128	239	223
August.....	264	506	108	204	202	215	128	222	211
September...	272	515	102	162	193	217	131	194	230
October.....	265	550	104	164	178	219	133	193	223

Wholesale Prices of Phosphates and Potash * *

	Superphosphate, Baltimore, per unit	Florida land, pebble, 68% f.o.b. mines, bulk, per ton	Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton	Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports [1]	Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports [2]	Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports [3]	Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports [4]
1910–14	$0.536	$3.61	$4.88	$0.714	$0.953	$24.18	$0.657
1929	.609	3.18	5.50	.672	.962	26.59	.610
1930	.542	3.18	5.50	.681	.973	26.92	.618
1931	.485	3.18	5.50	.681	.973	26.92	.618
1932	.458	3.18	5.50	.681	.963	26.90	.618
1933	.434	3.11	5.50	.662	.864	25.10	.601
1934	.487	3.14	5.67	.486	.751	22.49	.483
1935	.492	3.30	5.69	.415	.684	21.44	.444
1936	.476	1.85	5.50	.464	.708	22.94	.505
1937	.510	1.85	5.50	.508	.757	24.70	.556
1938	.492	1.85	5.50	.523	.774	15.17	.572
1939	.478	1.90	5.50	.521	.751	24.52	.570
1940	.516	1.90	5.50	.517	.730	24.75	.573
1941	.547	1.94	5.64	.522	.780	25.55	.367
1942	.600	2.13	6.29	.522	.810	25.74	.205
1943	.631	2.00	5.93	.522	.786	25.35	.195
1944	.645	2.10	6.10	.522	.777	25.35	.195
1945	.650	2.20	6.23	.522	.777	25.35	.195
1946	.671	2.41	6.50	.508	.769	24.70	.190
1947	.746	3.05	6.60	.432	.706	18.93	.195
1948	.764	4.27	6.60	.397	.681	14.14	.195
1949	.770	3.88	6.22	.397	.703	14.14	.195
1950	.763	3.83	5.47	.371	.716	14.33	.195
1951	.813	3.98	5.47	.401	.780	15.25	.200
1952	.849	3.98	5.47	.401	.793	15.25	.200
1953	.878	....	....	....	.793	15.25	.200
1954							
November	.895	....	....	.388	.765	14.75	.184
December	.895	....	....	.405	.825	16.00	.193
1955							
January	.895	....	....	.405	.825	16.00	.193
February	.895	....	....	.405	.825	16.00	.193
March	.895	....	....	.405	.825	16.00	.193
April	.895	....	....	.405	.825	16.00	.193
May	.895	....	....	.405	.825	16.00	.193
June	.895	....	....	.360	.720	13.45	.175
July	.895	....	....	.390	.735	14.00	.193
August	.895	....	....	.390	.735	14.00	.193
September	.895	....	....	.390	.735	14.00	.193
October	.895	....	....	.390	.735	14.00	.193
			Index Numbers (1910-14 = 100)				
1929	114	88	113	94	101	110	93
1930	101	88	113	95	102	111	94
1931	90	88	113	95	102	111	94
1932	85	88	113	95	101	111	94
1933	81	86	113	93	91	104	91
1934	91	87	110	68	79	93	74
1935	92	91	117	58	72	89	68
1936	89	51	113	65	74	95	77
1937	95	51	113	71	79	102	85
1938	92	51	113	73	81	104	87
1939	89	53	113	73	79	101	87
1940	96	53	113	72	77	102	87
1941	102	54	110	73	82	106	87
1942	112	59	129	73	85	106	84
1943	117	55	121	73	82	105	83
1944	120	58	125	73	82	105	83
1945	121	61	128	73	82	105	83
1946	125	67	133	71	81	102	82
1947	139	84	135	70	74	78	83
1948	143	118	135	67	72	58	83
1949	144	108	128	67	74	58	83
1950	142	106	112	68	75	59	83
1951	152	110	112	72	82	63	83
1952	158	110	112	72	83	63	83
1953	164	...	...	73	83	63	83
1954							
November	167	...	...	70	80	61	81
December	167	...	...	72	87	66	83
1955							
January	167	...	...	72	87	66	83
February	167	...	...	72	87	66	83
March	167	...	...	72	87	66	83
April	167	...	...	72	87	66	83
May	167	...	...	72	87	66	83
June	167	...	...	66	76	56	80
July	167	...	...	70	77	58	82
August	167	...	...	70	77	58	82
September	167	...	...	70	77	58	82
October	167	...	...	70	77	58	82

Wholesale Prices of Ammoniates * *

	Nitrate of soda bulk per unit N	Sulphate of ammonia bulk per unit N	Cottonseed meal S. E. Mills per unit N	Fish, scrap, dried 11–12% ammonia, 15% bone phosphate, f.o.b. factory bulk per unit N	Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N	High grade ground blood, 16–17 % ammonia, Chicago, bulk, per unit N
1910–14	$2.68	$2.85	$3.50	$3.53	$3.37	$3.52
1929	2.57	2.04	5.64	5.00	4.61	5.72
1930	2.47	1.81	4.78	4.96	3.79	4.58
1931	2.34	1.46	3.10	3.95	2.11	2.46
1932	1.87	1.04	2.18	2.18	1.21	1.36
1933	1.52	1.12	2.95	2.86	2.06	2.46
1934	1.52	1.20	4.46	3.15	2.67	3.27
1935	1.47	1.15	4.59	3.10	3.06	3.65
1936	1.53	1.23	4.17	3.42	3.58	4.25
1937	1.63	1.32	4.91	4.66	4.04	4.80
1938	1.69	1.38	3.69	3.76	3.15	3.53
1939	1.69	1.35	4.02	4.41	3.87	3.90
1940	1.69	1.36	4.64	4.36	3.33	3.39
1941	1.69	1.41	5.50	5.32	3.76	4.43
1942	1.74	1.41	6.11	5.77	5.04	6.76
1943	1.75	1.42	6.30	5.77	4.86	6.62
1944	1.75	1.42	7.68	5.77	4.86	6.71
1945	1.75	1.42	7.81	5.77	4.86	6.71
1946	1.97	1.44	11.04	7.38	6.60	9.33
1947	2.50	1.60	12.72	10.66	12.63	10.46
1948	2.86	2.03	12.94	10.59	10.84	9.85
1949	3.15	2.29	10.11	13.18	10.73	10.62
1950	3.00	1.95	11.01	11.70	10.21	9.36
1951	3.16	1.97	13.20	10.92	10.18	10.09
1952	3.34	2.09	13.95	11.27	9.72	9.16
1953	3.26	2.27	11.04	11.19	7.39	7.09
1954						
November	2.98	2.18	11.85	11.78	8.80	9.23
December	2.98	2.18	11.98	12.41	8.50	8.35
1955						
January	2.98	2.18	12.00	12.35	8.32	8.32
February	2.98	2.18	11.16	12.23	8.50	8.50
March	2.98	2.18	10.47	12.45	7.82	7.82
April	2.98	2.18	9.90	12.41	6.68	6.23
May	2.98	2.16	9.97	11.92	6.19	6.25
June	2.98	2.02	9.91	11.55	6.23	5.92
July	2.98	2.02	10.01	9.43	6.68	7.14
August	2.98	2.07	9.88	11.12	7.04	6.86
September	2.98	2.05	9.29	11.60	6.75	6.53
October	2.98	2.07	9.17	13.01	7.47	7.16
	Index Numbers (1910-14 = 100)					
1929	96	72	161	142	137	162
1930	92	64	137	141	112	130
1931	88	51	89	112	63	70
1932	71	36	62	62	36	39
1933	59	39	84	81	97	71
1934	59	42	127	89	79	93
1935	57	40	131	88	91	104
1936	59	43	119	97	106	131
1937	61	46	140	132	120	122
1938	63	48	105	106	93	100
1939	63	47	115	125	115	111
1940	63	48	133	124	99	96
1941	63	49	157	151	112	126
1942	65	49	175	163	150	192
1943	65	50	180	163	144	189
1944	65	50	219	163	144	191
1945	65	50	223	163	144	191
1946	74	51	315	209	196	265
1947	93	56	363	302	374	297
1948	107	71	370	300	322	280
1949	117	80	289	373	318	302
1950	112	68	315	331	303	266
1951	118	69	377	310	302	287
1952	125	74	399	319	288	260
1953	122	80	315	317	219	201
1954						
November	111	76	339	334	261	262
December	111	76	342	352	252	237
1955						
January	111	76	343	350	247	236
February	111	76	319	346	252	241
March	111	76	299	353	232	222
April	111	76	283	352	198	177
May	111	76	285	338	184	178
June	111	71	283	327	185	168
July	111	71	286	267	198	203
August	111	73	282	315	209	195
September	111	72	265	329	200	186
October	111	73	262	369	222	203

Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and All Commodities

	Farm prices*	Prices paid by farmers for commodities bought*	Wholesale prices of all commodities†	Fertilizer material‡	Chemical ammoniates	Organic ammoniates	Superphosphate	Potash**
1929.....	148	150	139	114	79	146	114	97
1930.....	125	140	126	105	72	131	101	99
1931.....	87	119	107	83	62	83	90	99
1932.....	65	102	95	71	46	48	85	99
1933.....	70	104	96	70	45	71	81	95
1934.....	90	118	109	72	47	90	91	72
1935.....	109	123	117	70	45	97	92	63
1936.....	114	123	118	73	47	107	89	69
1937.....	122	130	126	81	50	129	95	75
1938.....	97	122	115	78	52	101	92	77
1939.....	95	121	112	79	51	119	89	77
1940.....	100	122	115	80	52	114	96	77
1941.....	124	130	127	86	56	130	120	77
1942.....	159	149	144	93	57	161	112	77
1943.....	193	165	151	94	57	160	117	77
1944.....	197	174	152	96	57	174	120	76
1945.....	207	180	154	97	57	175	121	76
1946.....	236	197	177	107	62	240	125	75
1947.....	276	231	222	130	74	362	139	72
1948.....	287	250	241	134	89	314	143	70
1949.....	250	240	226	137	99	319	144	70
1950.....	258	246	232	132	89	314	142	72
1951.....	302	271	258	139	93	331	152	76
1952.....	288	273	251	144	98	333	158	76
1953.....	258	262	247	139	100	269	164	77
1954								
November.	244	262	248	140	93	301	167	74
December..	239	261	245	140	93	300	167	77
1955								
January...	244	264	248	140	93	297	167	77
February..	245	264	248	139	93	291	167	77
March....	244	265	248	137	93	275	167	77
April.....	247	265	248	135	93	252	167	77
May.....	244	263	248	134	93	243	167	77
June.....	243	263	248	131	90	242	167	70
July.....	237	262	248	132	90	240	167	74
August....	233	260	248	133	91	252	167	74
September.	235	259	250	132	91	244	167	74
October...	230	261	250	134	91	259	167	74

* U. S. D. A. figures, revised January 1950. Beginning January 1946 farm prices and index numbers of specific farm products revised from a calendar year to a crop-year basis. Truck crops index adjusted to the 1924 level of the all-commodity index.

† Department of Labor index converted to 1910-14 base.

‡ The Index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management, Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] Beginning July 1949, baled hay prices reduced by $4.75 a ton to be comparable to loose hay prices previously quoted.

[2] Potash salts quoted F.O.B. mines; manure salts since June 1941; other carriers since June 1947. Beginning June 1954, muriate of potash quoted on both mine and port basis.

*** * Where range of prices for fertilizer material is quoted, average figure is used. The weighted average of prices actually paid for potash is lower than the annual average because since 1926 over 90% of the potash used in agriculture has been contracted for during the discount period.**

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

"Trial of a Proprietary Plant Food to Improve Color in Christmas Trees," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., Forestry Note 56, March 1955, H. W. Fox.

"Commercial Fertilizer Results with Winter Wheat and Rye, 1955," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Outstate Testing Cir. 45, Aug. 1955, G. W. Lowrey, R. A. Olson, and P. L. Ehlers.

"Fertilizers and Limes—1954," Agr. Exp. Sta., Rutgers Univ., New Brunswick, N. J., Insp. Series 57, Feb. 1955, S. B. Randle.

"Effect of Fertilizers and Micro Elements on Alfalfa Hay Yields," Agr. Exp. Sta., N. Mex. A. & M. College, State College, N. Mex., Press Bul. 1139, April 1955, H. E. Dregne.

"Small Grain Fertilizer Demonstrations, Oklahoma—1954," Agr. Ext. Serv., Okla. A. & M. College, Stillwater, Okla., Cir. 617, G. Hanes and W. Chaffin.

"Inspection of Fertilizers Made for the State Department of Agriculture and Conservation," Agr. Exp. Sta., Univ. of R. I., Kingston, R. I., Ann. Fert. Cir., Jan. 1955, R. W. Gilbert, C. E. Olney, and J. B. Colson.

"Fertilizer Recommendations for the Lower Rio Grande Valley," Agr. Ext. Serv., Tex. A. & M. College, College Station, Tex., L-222, 1955, M. K. Thorton, B. Hancock, and W. R. Cowley.

"Fertilizer Recommendations for the Upper Rio Grande, El Paso, Pecos, and Van Horn Irrigated Areas," Agr. Ext. Serv., Tex. A. & M. College, College Station, Tex., L-223, 1955, M. K. Thornton, B. Hancock, P. J. Lyerly, and J. J. Bayles.

"Fertilizer Recommendations for the High Plains," Agr. Ext. Serv., Tex. A. & M. College, College Station, Tex., L-226, 1955, M. K. Thornton, B. Hancock, and D. L. Jones.

"Fertilizer Recommendations for the Rio Grande Plain," Agr. Ext. Serv., Tex. A. & M. College, College Station, Tex., L-227, 1955, M. K. Thornton, B. Hancock, B. Perry, and R. A. Hall.

"Distribution of Fertilizer Sales in Texas, January 1 to June 30, 1955," Agr. Exp. Sta., Tex. A. & M. College, College Station, Tex., Prog. Rpt. 1806, Aug. 1955, J. F. Fudge.

"Fertilizer Requirements of Alfalfa Hay in Utah," Agr. Exp. Sta., Utah State Agr. College, Logan, Utah, Bul. 374, April 1955, R. F. Nielson, J. P. Thorne, and G. T. Baird.

"The Fertilizer Situation for 1955-1956," USDA, Wash., D. C., Sept. 1955, A. L. Mehring and C. Graham.

Soils

"Irrigation of Cotton in Arkansas," Agr. Exp. Sta., Univ. of Ark., Fayetteville, Ark., Bul. 552, May 1955, D. A. Brown, R. H. Benedict, and B. B. Bryan.

"Soil Associations of Sarasota County, Florida," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Cir. S-84, June 1955, R. G. Leighty, O. E. Cruz, R. Wildermuth, and F. B. Smith.

"Irrigation and Vegetable Yields in Middle and North Georgia," Agr. Exp. Sta., Univ. of Ga., Athens, Ga., Cir. N. S. 1, Oct. 1954, B. O. Fry and J. E. Bailey.

"Should I Plan to Irrigate in Georgia?" Agr. Exp. Sta., Univ. of Ga., Athens, Ga., Mimeo. Series N. S. 11, July 1955, W. J. Foreman and J. R. Russell.

"Soil Fertility Investigations at Columbus Experiment Field, 1924-54," Agr. Exp. Sta., Kans. State College, Manhattan, Kans., Bul. 372, July 1955, F. W. Smith, F. E. Davidson, and V. H. Peterson.

"Summary of Experimental Results at the Campbellsville Soil Experiment Field," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., Misc. 29, July 1955, E. C. Doll and P. Sutton.

"Summary of Experimental Results at the Greenville Soil Experiment Field," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., Misc. 30, July 1955, E. C. Doll and P. Sutton.

"Cationic Saturation of Low Exchange Soils for Growth of Vegetable Crops," Agr. Exp. Sta., Univ. of Mo., Columbia, Mo., Res. Bul. 575, Jan. 1955, V. N. Lambeth.

Soil Fertility and Small Grain Production," Agr. Exp. Sta., Univ. of Mo., Columbia, Mo., Bul. 657, July 1955, G. E. Smith, W. J. Upchurch, J. A. Roth, and M. Brown.

"Fertility Levels of New Mexico Soils," Agr. Exp. Sta., N. Mex. A. & M. College, State College, N. Mex., Bul. 396, June 1955, H. E. Dregne and H. J. Maker.

"Soil Survey, Waldo County, Maine," USDA, Wash., D. C., Series 1940, No. 16.

"Soil Survey, Knox County, Tennessee," USDA, Wash., D. C., Series 1942, No. 10.

"Soil Survey, Pierce County, Washington," USDA, Wash., D. C., Series 1939, No. 27.

Crops

"Muscadine Grapes in Alabama," Agr. Ext. Serv., Ala. Polytechnic Institute, Auburn, Ala., Cir. 478, May 1955, J. Bagby and T. B. Hagler.

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"Experimental Farm Highlights in the Atlantic Provinces," Exp. Farms Serv., Dept. of Agr., Ottawa, Ont., Can., March 1955.

"Annual Winter Grazing in the Coastal Plain of Georgia," Agr. Exp. Sta., Univ. of Ga., Athens, Ga., Mimeo. Series N. S. 13, Sept. 1955, B. L. Southwell and S. A. Parham.

"Idaho Bountiful and Golden Gem Snap Beans Resistant to Mosaic and Curly Top," Agr. Exp. Sta., Univ. of Idaho, Moscow, Idaho, Bul. 217, Aug. 1954, L. Dean and C. W. Hungerford.

"Cody Oats," Agr. Exp. Sta., Univ. of Idaho, Moscow, Idaho, Bul. 229, March 1955, H. Stevens.

"Soybeans in Indiana," Agr. Ext. Serv., Purdue Univ., Lafayette, Ind., Ext. Bul. 231, March 1955, K. E. Beeson and A. H. Probst.

"The Lawn, How to Establish and Maintain," Agr. Ext. Serv., Purdue Univ., Lafayette, Ind., Ext., Bul. 254, April 1955, W. H. Daniel, R. B. Hull, O. C. Lee, G. E. Lehker, and E. G. Sharvelle.

"Crops and Soils Field Day Report," Agr. Exp. Sta., Kans. State College, Manhattan, Kans., Cir. 323, June 1955, K. L. Anderson.

"Your Vegetable Garden Month by Month," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., Cir. 376, Rev. May 1955, J. S. Gardner.

"Research in Agriculture, Annual Report, 1953-54," Agr. Exp. Sta., La. State Univ., Baton Rouge, La.

"Crops and Soils Departmental Annual Report for 1954," Agr. Exp. Sta., La. State Univ., Baton Rouge, La.

"46th Annual Progress Report, Rice Experiment Station, Crowley, Louisiana, 1954," Agr. Exp. Sta., La. State Univ., Baton Rouge, La.

"Production of Cauliflower, Broccoli, and Brussels Sprouts," Agr. Exp. Sta., La. State Univ., Baton Rouge, La., Ext. Pub. 1169, Sept. 1954, J. Montelaro and R. T. Brown.

"Louisiana Lespedeza," Agr. Exp. Sta., La. State Univ., Baton Rouge, La., Ext. Pub. 1181, March 1955, R. A. Wasson.

"Louisiana Soybeans . . . Oil Type Beans," Agr. Exp. Sta., La. State Univ., Baton Rouge, La., Ext. Pub. 1183, March 1955, R. A. Wasson and A. G. Killgore.

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"Garden Hedges-New & Renewed," Agr. Ext. Serv., Univ. of Mass., Amherst, Mass., Lflt. 280, March 1955, R. E. Pride and A. W. Boicourt.

"Forage Mixtures," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., Ext. Fldr. 182, Rev. Sept. 1955, A. R. Schmid, H. E. Jones, R. A. Briggs, and R. E. Bennett.

"Woody Plants for Minnesota," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., Ext. Bul. 267, Rev. June 1955, L. C. Snyder and M. E. Smith.

"Pecan Production," Agr. Ext. Serv., Miss. State College, State College, Miss., Pub. 297, June 1955, C. Hines and A. C. Gossard.

"Sweet Corn for Market," Agr. Ext. Serv., Miss. State College, State College, Miss., Pub. 307, June 1955, K. H. Buckley.

"Lima Beans . . . Bush and Pole," Agr. Ext. Serv., Miss. State College, State College, Miss., Pub. 308, June 1955, K. H. Buckley.

"The Montana Vegetable Garden," Agr. Ext. Serv., Mont. State College, Bozeman, Mont., Bul. 281, Feb. 1955, L. A. Yager.

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"Sweet Cherry Growing in Eastern Washington," Agr. Ext. Serv., State College of Wash., Pullman, Wash., Ext. Mimeo. 1682, May 1955.

"Asparagus Growing in Washington," Agr. Ext. Serv., State College of Wash., Pullman, Wash., Ext. Mimeo. 1687, May 1955.

"Dry Bean Production in the Eastern States," USDA, Wash., D. C., Farmers' Bul. 2083, Aug. 1955, A. L. Andersen.

"Sphagnum Moss for Plant Propagation," USDA, Wash., D. C., Farmers' Bul. 2085, July 1955, J. L. Creech, R. F. Dowdle, and W. O. Howley.

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"Seasonal Variations in Prices Received by Alabama Farmers," Agr. Exp. Sta., Ala. Polytechnic Institute, Auburn, Ala., Bul. 295, June 1955, M. White and J. H. Yeager.

"Agricultural Statistics for Ontario, Year 1954," Statistics and Pub. Br., Dept. of Agr., Toronto, Ont., Can.

"Late Potato Production Costs Based on a Three-year Study Covering 461 Fields in the Main Late Potato Areas of Ontario," Farm Econ. Br., Dept. of Agr., Toronto, Ont., Can.

"1955 Market Factors, Connecticut Valley Types of Cigar Binder Tobacco," Agr. Exp. Sta., Univ. of Conn., Storrs, Conn., Prog. Rpt. 10, Sept. 1955. A. W. Dewey.

"Delaware's Competitive Position in the Production of Tomatoes for Processing," Agr. Exp. Sta., Univ. of Del., Newark, Del., Tech. Bul. 313, June 1955, W. E. McDaniel.

"Citrus Grove Records," Agr. Ext. Serv., Univ. of Fla., Gainesville, Fla., Econ. Series 55-3, Oct. 1955, Z. Savage.

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"Optimum Combinations of Competitive Crops at Particular Locations (Application of Linear Programmings 1)," Agr. Exp. Sta., Iowa State College, Ames, Iowa, Res. Bul. 426, April 1955, B. Bowlen and E. O. Heady.

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"Adjusting Farm Rents to Changes in Prices, Costs, and Production," Agr. Exp. Sta., Iowa State College, Ames, Iowa, Spec. Rpt. 9, April 1955, W. E. Chryst and J. F. Timmons.

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Nitrogen Influences Intake . . .

(*From page* 18)

The amount that the cation exchange capacity of the roots was increased varied with the crop (Table I). In the case of oats it amounted to 40% of the value at the low level. For corn the increase was about 30%; and for the other crops, except vetch, it was roughly 10%. Whether these values would be still greater with older plants (as is suggested by the results for buckwheat) remains to be determined.

As Dr. Drake has pointed out (BETTER CROPS, May 1952) an increase in the C.E.C. of roots would enhance their competitive ability for obtaining divalent cations like calcium and magnesium. Also as mentioned above, the increase in C.E.C. would aid in the release and uptake of extra phosphate. On the other hand, an increased C.E.C. would decrease the ability of roots to take from the soil a monovalent cation such as potassium. Aside from the fact that more roots and tops would generally be produced, this decreased ability to adsorb potassium might well be another reason why more potash fertilizer is often required for maximum yields of crops when high rates of nitrogen have been applied.

It is of interest to note here that the cereal crops were more markedly affected by the increments of nitrogen than were the other crops. This fact may be of considerable significance in small grain-legume or grass-legume seedings. As mentioned by Dr. Drake the compatibility or lack of it among

TABLE I.—CATION EXCHANGE CAPACITIES AND PERCENTAGES OF NITROGEN IN ROOTS AND TOPS OF SEVERAL CROPS (SEEDLINGS) GROWN IN GRAVEL CULTURES BATHED WITH SOLUTIONS OF THREE NITROGEN LEVELS

Plants	Nitrogen levels*	C.E.C.†	% Nitrogen	
			Roots	Tops
Oats (15 day)	Low	17.7	1.29	3.50
Oats (15 day)	Medium	21.0	1.51	4.15
Oats (15 day)	High	24.4	2.14	5.08
Corn (15 day)	Low	21.6	1.61	3.16
Corn (15 day)	Medium	24.6	1.75	3.21
Corn (15 day)	High	27.4	1.96	3.84
Buckwheat (15 day)	Low	41.6	2.00	1.98
Buckwheat (15 day)	Medium	42.4	2.05	2.41
Buckwheat (15 day)	High	44.0	2.25	3.00
Buckwheat (38 day)	Low	46.8	2.13	1.79
Buckwheat (38 day)	Medium	49.6	2.50	2.41
Buckwheat (38 day)	High	51.8	2.77	3.32
Cotton (25 day)	Low	44.7	2.35	4.84
Cotton (25 day)	Medium	45.9	2.65	5.39
Cotton (25 day)	High	50.0	3.03	6.40
Vetch (25 day)	Low	52.4	4.72	6.57
Vetch (25 day)	Medium	48.2	4.69	6.60
Vetch (25 day)	High	50.3	5.24	7.33
Soybeans (25 day)	Low	54.6	3.93	7.18
Soybeans (25 day)	Medium	56.3	4.24	7.10
Soybeans (25 day)	High	60.9	4.21	7.21

* ⅛ normal, normal, and twice normal nitrogen (nitrate) levels of ⅛ Hoagland solution.
† Cation exchange capacity in milliequivalents per 100 grams of dry roots.

grass-legume mixtures can be greatly affected by the crops we choose for the mixtures. Those more nearly alike in the C.E.C. of their roots are less competitive for potassium and thus more compatible. If the results on cereals can be used as an index for all grasses, it appears then that application of nitrogen to a given grass-legume mixture would make the crops more compatible. The reason is the C.E.C. of their roots would be made more nearly alike and there would then be less tendency for the grass to "hog" the potassium away from the legume.

More studies need to be completed before the full significance of the role of these various factors can be stated. Practical significance of the effect of nitrogen on the C.E.C. of plant roots would seem to be that herein lies an interrelationship between all fertilizer and lime elements. Through its influence upon the C.E.C. of the roots, application of nitrogen may thereby affect plant's recently-recognized ability to differentially compete with one another and with the soil for phosphate, potassium, calcium, and magnesium.

Why More Alfalfa?

(*From page* 26)

perennial legumes, but our experiments show that all varieties of red clover have less than half of a normal stand during the second harvest year. The yields of red clover were low as compared with other legumes, Fig. 4, because the yields in the second harvest year were low due to poor stands. The improved varieties of red clover should be considered as biennials when utilized in practical grassland programs.

Land sown to alsike clover should continue to decrease in the future because this legume makes one good yield in the spring with practically no aftermath growth. In our experiments, the second growth of alsike clover has been so poor that it was not worth harvesting the herbage. Many farmers are of the opinion that alsike clover is a perennial, but it is quite certain that the new alsike growth from year to year comes from volunteer seedlings.

Ladino and all white clovers have behaved as short-lived perennials, and the stands often disappear in two years. The white clovers are short-lived because they are subject to injury from drought, low and high temperatures, and diseases. All white clover varieties are shallow-rooted, hence they produce less during prolonged dry periods than other legumes. Morphologically, the white clovers also have disadvantages when compared with other legumes. White clovers spread laterally by surface runners called stolons, and new top growth and root shoots develop from stolon buds. Because these surface growing points are often exposed to sudden high and low air temperatures and to drought, ladino and other white clover stands are often lost.

Under closely grazed conditions accompanied by dry weather, many populations of white clover are lost because the stolons lying on the soil surface dried out. During winter months without snow cover, stolons of white clover are often killed because of the exposure to high and low alternating daily temperatures.

The main crown roots of white clover, which develop during seedling establishment, root deeper than stolon roots. New stands of ladino and other white clovers are injured less by adverse temperatures and low moisture than old stands, because new stands of clover have more plants with crown roots. The average life of crown roots is not known, but because of diseases and other factors it is often less than three years.

We have been experimenting with birdsfoot trefoil for six years, but the varieties thus far tested are all short-lived. It has been possible to get good productive stands even during the seed-

Fig. 6. During dry summer weather an alfalfa-orchard grass mixture (right) made much more growth than a mixture of Kentucky 31 fescue with ladino clover (left). The recovery period is identical for the two mixtures photographed at the Research Station near Warsaw, Virginia.

ing year, but the plants degenerate with age of the stand due to diseases and aggressive competition of other grasses and legumes during the spring season. Perennial lespedezas are drought-tolerant, but they are not used extensively because of the low palatability and low production. The primary disadvantages of both annual and perennial lespedezas are their short growing season and failure to produce feed during the most dependable growing season in early spring.

When compared with the warm season legumes, annual and perennial lespedeza, alfalfa is a full season legume, thus it produces higher yields. The deep root system makes a large supply of moisture available for alfalfa, hence, alfalfa is affected less by prolonged drought than other cool season legumes. The short stems that develop new shoots are covered with soil; this soil coverage protects alfalfa during adverse temperature and moisture periods. When comparing alfalfa with other cool season legumes during the last six years, we have come to the conclusion that good stands and high yields of alfalfa can be maintained over a longer period of years than for other legumes. It should be pointed out that alfalfa has also distinct disadvantages in that it requires rather specific cutting management and culture when compared with other legumes.

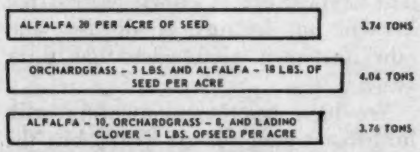

ALFALFA 20 PER ACRE OF SEED
3.74 TONS
ORCHARDGRASS – 3 LBS. AND ALFALFA – 18 LBS. OF SEED PER ACRE
4.04 TONS
ALFALFA – 10, ORCHARDGRASS – 8, AND LADINO CLOVER – 1 LBS. OFSEED PER ACRE
3.76 TONS

Fig. 7. In an experiment at Middleburg, Virginia, the yields of alfalfa mixtures were higher than for alfalfa sown alone. The data are averages for a four-year period, 1950-53.

Alfalfa Used Alone or in Mixtures

Many farmers are of the opinion that alfalfa must be sown in pure stands to get high yields and a long productive life. Alfalfa stands can be maintained when sown with an aggressive grass like orchard grass, provided a light sowing rate of about three pounds of grass and good cutting and fertilizer practices are used. Our experiments and field plantings are five years old, and the stands of alfalfa in grass mixtures are still satisfactory. We are conducting experiments with alfalfa-grass mixtures on several different soils and locations. At the Northern Virginia Pasture Research Station, a pure seeding of alfalfa produced an average of 3.74 tons of hay during a four-year period, Fig. 7. In this same experiment a mixture of alfalfa with orchard grass produced 4.04 tons as compared with 3.76 tons of hay when an alfalfa-orchard grass-ladino clover mixture was used. Although an alfalfa-orchard grass mixture produced higher yields than alfalfa at Middleburg, alfalfa alone produced slightly more hay than an alfalfa-grass mixture at Blacksburg. At Blacksburg, alfalfa alone produced 5 tons as compared with 4.81 tons of hay per acre for an alfalfa-orchard grass mixture during a four-year period, Table I. The hay yields during the first year were 4 tons for alfalfa as compared with 4.8 tons for an alfalfa-orchard grass mixture. The use of a grass with alfalfa reduced the weediness during the first harvest year.

TABLE I.—THE YIELD OF ALFALFA SEEDED ALONE AND WITH ORCHARD GRASS DURING A FOUR-YEAR PERIOD AT BLACKSBURG, VIRGINIA.

Mixture and seeding rate in pounds per acre	1951	1952	1953	1954	Average
Alfalfa—18 lbs. with 3 lbs. of orchard grass..	4.80	4.88	5.00	4.56	4.81
Alfalfa 20 lbs.....	4.00	5.07	6.08	4.85	5.00

During dry years alfalfa-grass mixtures generally yield less than pure stands of alfalfa. Likewise, during wet seasons alfalfa-grass mixtures generally yield as much or more than pure seedings of alfalfa. The higher yields from alfalfa-grass mixtures than from alfalfa at Middleburg are attributed to favorable moisture. At Blacksburg, except for the first season, there were prolonged low moisture periods.

Although alfalfa-grass mixtures may not yield much more than alfalfa grown alone, why use alfalfa with grass in mixtures? In fields or spots within fields where alfalfa plants are lost due to poor environment or adaptation, grasses compensate for the lack of alfalfa plants, thereby prolonging the productive period of a field. Grasses have been found to lengthen the productive life of alfalfa in areas where alfalfa is well adapted. Chickweed is usually less serious in alfalfa-grass mixtures than for pure stands of alfalfa. The denser sod of alfalfa-grass mixtures reduces chickweed as well as other weedy growths. In old stands, where some alfalfa plants die because of root or other diseases, the grass in an alfalfa-grass mixture helps crowd out weeds.

Hay from alfalfa-grass mixtures is easier to cure than for pure alfalfa. Alfalfa-grass mixtures are more suitable for flexible management and utilization than pure seedings of alfalfa.

Alfalfa for Silage, Hay, Grazing, and Green Feeding

Alfalfa is a very popular hay crop,

Fig. 8. This 35-acre field of an alfalfa-orchard grass mixture is being harvested for silage in early spring of the fifth productive year at Middleburg. Four cuttings per year (early cut silage and three hay cuttings) have averaged over four tons of hay equivalent per acre.

but it is also a good crop for silage, grazing, and chopping for green feeding. Mixtures of alfalfa with three pounds of orchard grass per acre have produced high yields over a five-year period, when cut early for silage followed with three hay cuts taken in the tenth bloom stage, Fig. 8. Cuttings made in early spring when orchard grass begins to head produce excellent quality silage. Where preservatives are not used, alfalfa-orchard grass mixtures make a sweeter smelling silage than alfalfa without grass. The first harvest of alfalfa-grass mixtures taken for silage generally yields more than alfalfa without grass. Orchard grass is ready for cutting earlier in the spring than alfalfa and this first erect crop of orchard grass is competitive toward alfalfa, unless early cutting is practiced.

Grasses do not reduce the quality of alfalfa, except with late cutting in the first harvest. The stemminess of the grass as well as the alfalfa is reduced by early cutting. In the aftermath growth, grasses like orchard grass are leafy as compared to alfalfa, hence leafy grasses actually improve the value of alfalfa hay crops.

Early cutting for silage encourages a rapid aftermath growth of alfalfa, which may be used for hay or grazed.

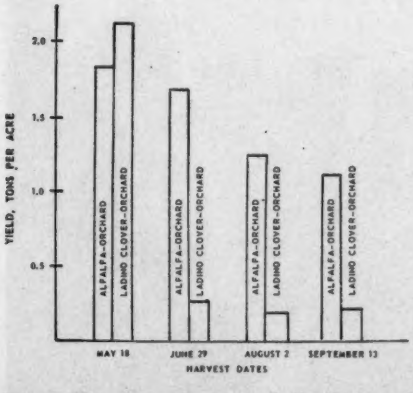


Fig. 9. This shows the seasonal distribution of hay (15% moisture) from a four-year-old stand of alfalfa-orchard grass and a two-year-old stand of an orchard grass-ladino clover mixture during the 1954 growing season. (Rotation experiment, Middleburg, Virginia).

Alfalfa-orchard grass mixtures produce high aftermath yields as compared with ladino clover-grass mixtures, Figs. 6 and 9. At Middleburg in 1954, an alfalfa-orchard grass mixture that was cut four times produced 1.8 tons of hay equivalent in the early silage cut taken on May 18 and 4 tons of hay in the three aftermath cuttings. A ladino clover-orchard grass mixture produced 2.1 tons in the first harvest and only .6 of a ton in the three aftermath cuts. The total yield of the alfalfa mixture was 5.8 tons as compared to 2.7 tons for the ladino clover. The alfalfa mixture produced 69% of its growth during the dry summer months and ladino clover made only 23% of its growth during the summer.

The excellent summer growth of alfalfa stresses the importance of using this plant as a supplementary grazing crop when shallow-rooted pasture mixtures are low in production, Fig. 10. By using grass with alfalfa, the mixture can be grazed as the bloat problem is lessened. Good grass growth is necessary in alfalfa to minimize the incidence of bloat. Grasses like timothy and bromegrass are not satisfactory as these two grasses make very poor aftermath growth when compared with orchard grass. In our haying operations, we find that it is easier to cure alfalfa-orchard grass mixtures than alfalfa alone. An alfalfa-orchard grass mixture can be windrowed for hay making about a half day earlier than pure alfalfa. The orchard grass seems to "fluff up" the crop so that it dries out more readily.

Alfalfa in Rotations

Red clover and annual lespedeza are commonly used in short rotations in Virginia. On the other hand, alfalfa is generally used in isolated fields and not in a definite crop rotation plan. Alfalfa has a definite place in a planned 4- to 6-year-crop rotation. If alfalfa stands are cropped for 2 to 4 years they will have a decidedly favorable influence on the yields of tilled crops in

Fig. 10. Alfalfa-grass mixtures make good supplementary grazing crops because alfalfa produces more feed during dry seasons than other legumes. Cattle are not as apt to bloat when grazing alfalfa-grass mixtures as from alfalfa alone.

the rotation. The employment of alfalfa in crop rotations will require more lime and higher fertility levels than for red clover and lespedeza; however, alfalfa will produce higher yields than these short-lived legumes and fix more nitrogen for utilization by tilled crops. The deep rooting habit of alfalfa also improves the soil structure and the rooting depth of other crops in the rotation.

The cost of seeding alfalfa is higher than for red clover because it requires more lime, fertilizer, and seed per acre, but the higher hay yields compensate for this. It is not as difficult to obtain good stands of alfalfa as for other legumes when soil conditions are favorable for alfalfa crops. It is possible to get as high yields of alfalfa when seeded at the rate of 10 pounds per acre as for 20 pounds per acre with good seeding techniques under favorable environments, but 20 pounds of seed per acre are generally recommended.

Soil Sample Information Sheet . . .

(*From page* 22)

taken up by microorganisms. While the phosphorus does not show up in the test, it becomes available to plants during the season because the microorganisms die and the chemical compounds break down fairly readily to release phosphorus.

Rock phosphate applications must be recorded if good phosphate recommendations are to be made. The sulfuric acid used in the phosphorus test dissolves rock phosphate more readily than weak soil acids; therefore, while the phosphorus test is high, the crop may need phosphorus. The county agent must then recommend phosphorus according to general recommendations for the particular crop. Research is now being conducted to determine whether other tests for phosphorus may be more suitable for Kentucky soils than the one now in use.

Cropping History

Crops grown will indicate the nitrogen status of the soil. Continuous row cropping indicates a low nitrogen status

whereas a good legume-grass meadow or pasture indicates a medium nitrogen status.

Cover crop or sod crop turned under affects the nitrogen status. A good legume or legume-grass sod, or a good cover crop containing a legume indicates a medium nitrogen status. A poor sod containing few or no legumes indicates a low nitrogen status.

Crops to be grown must be known to make the recommendation. For example, a soil testing high in potassium does not need potash for corn, but up to 150 pounds of K_2O are needed for tobacco. Although the recommendations are made in terms of N-P_2O_5-K_2O, the county agent suggests mixed fertilizer grades or straight fertilizer materials that are available in his county and which will furnish the required nutrients. The information discussed not only helps the county agent to make an intelligent lime and fertilizer recommendation, but affords him a means of checking on his laboratory.

Potassium Deficiency of Alfalfa . . .

(*From page* 12)

ployed. Yields were measured by mowing 3 x 200 foot strips the length of each of the replicated treatments. Samples for tissue analysis were again taken at harvest. The results of these rate-placement tests are shown in Table V.

The 1950 tests showed striking increases in yield as a result of potassium applications. Harvest weights were taken at only one of the four commercial cuttings. Here, sod treatments with 200 pounds of potassium sulfate gave significantly greater yield and higher potash uptake than did equivalent surface treatments. At the 1,000-pound rate, however, yields were the same from each method of application, although the potassium uptake was greater where the material was placed in the sod. This test had to be discontinued because the field was plowed up and put into barley. No visible potassium effects were observed on the barley crop that followed.

The 1951 tests were set up to duplicate and supplement those carried out in 1950. As before, the 1,000-pound rate gave striking yield increases over the control, but no effect of placement was observed. Yields from the 500-pound rate were somewhat less than from the 1,000-pound rate. At both cuttings, yields and potassium uptake were greater from the sod applications. At the 200-pound rate, some advantage from sod placement and slightly greater uptake of potassium were obtained.

It should be noted that both the 1950

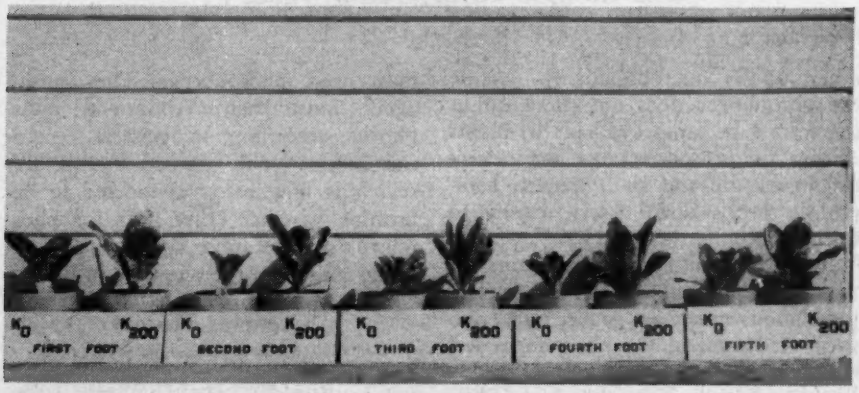


Fig. 2. Greenhouse response of lettuce to potassium as related to soil depth—Conejo loam from site of 1950 field tests.

TABLE VI.—POTASSIUM SUPPLY THROUGHOUT PROFILE OF CONEJO LOAM AS MEASURED BY PLANT GROWTH AND CHEMICAL EXTRACTIONS

Chemical data				Plant growth and composition					
Depth sample	Base exchange capacity meq/100 gm	Extractable K meq/100 gr.		Yields of successive crops dry weight per pot				Per cent K in ladino clover tops	
		Neutral Ammonium Acetate	.1 N H Cl	I. Lettuce		II. Ladino clover			
				K_0	K_{300}*	K_0	K_{200}	K_0	K_{200}
0–1′	33.0	.105	.109	2.5	4.6	2.9	7.7	.62	1.52
1–2′	29.4	.056	.066	1.0	2.9	.4	5.4	.45	1.78
2–3′	25.5	.056	.066	1.1	2.8	.7	5.1	.47	1.92
3–4′	22.6	.049	.053	1.6	3.4	.8	5.0	.46	1.34
4–5′	23.4	.049	.050	1.9	3.3	1.1	6.5	.51	1.10

* K_{300} from 400 lbs. K_2SO_4/acre applied only to lettuce crop.

and 1951 tests were really acutely deficient stands of alfalfa. The potassium values of middle stems on the untreated areas were only .34 to .37%, only about a half of the "critical level."

The soil from the 1951 location was sampled by horizons for laboratory and greenhouse study. Sufficient soil was collected from each of the first five feet to determine its potassium supply, both chemically and by plant growth. For the latter purpose, both ladino clover and lettuce were used as indicators. The chemical data in Table VI show the first foot to be much better supplied with potassium than lower depths. Plants show all layers to be deficient. (Figure 2).

Field Scale Rate-Placement Tests 1952-53-54: In July of 1952, a first-year stand already showing potassium deficiency was selected as the site for a field-scale demonstration of the correction of potassium deficiency. The entire "checks" across the field, each approximately three quarters of an acre in size and irrigated separately as basins, were treated with potassium sulfate. A "Pasture-Dream" fertilizer applicator, with rolling coulters and shoes for sod injection, was made available through the courtesy of the American Potash Institute. Applications of potassium sulfate were made with this machine, following an irrigation. Adjacent plots were treated with corresponding amounts of fertilizer applied with a standard "Easy-flow" broadcaster. Two rates of material—450 and 1,000 pounds—of sulfate of potash were applied. At each rate, broadcast and sod-drilling methods were compared. Treatments were replicated twice and yields of hay recorded for the balance of 1952 and for the entire 1953 and 1954 seasons. It was hoped by this technique that an accurate evaluation of the effect of potassium fertilization might be obtained and that the duration and magnitude of response might be thus determined. The data from this test is shown in Table VII.

It should be noted that the sod-placement applicator was able to get into the soil only 2 to 3 inches, and that a number of plants were ripped out in attempting to get the potassium into the soil. This difference may be shown by the data in 1952, where the yields from the drilled material were significantly less than where equivalent material was broadcast upon the surface. These differences persisted into the second year, but were almost en-

TABLE VII.—YIELD OF ALFALFA AS INFLUENCED BY RATE AND METHOD OF POTASSIUM APPLICATION

Three Years' Results—M & T Ranch—Butte County—1952-53-54

Materials applied July 1952—None additional

Treatment		Yields of alfalfa hay lbs./acre**				Gain from treatment lbs./acre	Fertilizer cost/acre	Fertilizer cost/ton increased yield	Profit/acre with hay worth***		
K_2SO_4* applied lbs./acre	Method	1952 2 cuttings	1953 4 cuttings	1954 5 cuttings	Total 3 years				$10/ton	$15/ton	$20/ton
None	—	2,419	6,675	6,546	15,640						
475	Broadcast	3,186	8,797	7,466	19,549	3,909	$16.94	$8.67	$+2.60	$+15.38	$26.15
450	Drilled	2,700	8,108	7,153	17,961	2,321	16.13	13.90	−4.52	+ 1.28	7.08
1,000	Broadcast	3,436	9,625	8,396	21,457	5,817	34.00	11.68	−4.95	+ 9.63	24.17
1,050	Drilled	2,955	9,483	9,006	21,444	5,804	35.63	12.27	−6.61	+ 7.90	22.40
L.S.D.—5% level between treatments		460	905	1,307	1,736	1,736					

* K_2SO_4 @ $65.00/ton, plus $1.50/acre to apply.
** Yield averages of 2 replicated treatments each approximately ¼ acre.
*** Price standing hay.

tirely gone during the third season.

The total production of hay over 2½ years was increased by 3,900 pounds as a result of the 475-pound broadcast treatment. The 1,000-pound broadcast rate of potassium sulfate increased production almost three tons. The increased production from the four fertilizer treatments has been evaluated in terms of the fertilizer applied. The 475-pound broadcast treatment produced nearly two tons of additional hay at a cost of $8.67 per ton of increased production. In contrast, the 1,000-pound broadcast treatment produced nearly three tons of extra hay, at a fertilizer cost of nearly $12.00 a ton.

The profit per acre from the fertilizer operation is shown in the last section of Table VII. With standing hay worth $10.00 a ton, a net profit of $2.60 per acre above the cost of fertilizer and application would have been obtained from the 475-pound sulfate of potash treatments. All other treatments would have lost money.

With standing hay at $15.00 a ton, a $15.00 an acre profit would have resulted from the application of 475 pounds of potassium sulfate, broadcast at an initial cost of $16.94. With still higher priced hay, at $20.00 a ton standing, the heavy treatments would return nearly the same profit per acre as the low broadcast treatment.

It seems clear that potassium deficiency of alfalfa may be corrected and that broadcast application may produce additional hay at a fertilizer cost of approximately $9.00 to $12.00 for an additional ton of hay produced. Clearly the benefits of increased volume of production and longer life of stand have additional value.

Use of Tissue Analysis in Evaluating Potassium Status of Alfalfa

Greenhouse Calibration Curves: In the alfalfa nutrient survey which formed the first part of this report, the K content of middle stems of alfalfa was used as a measure of potassium status of the plants. The levels or values of potassium in the middle stems, representing deficiency and adequacy, were derived from curves developed from greenhouse tests in which alfalfa was grown in a range of nutrient solutions varying widely in potassium content.

A typical curve showing the relationship between total yield and K content of middle stems in a greenhouse water culture experiment is presented

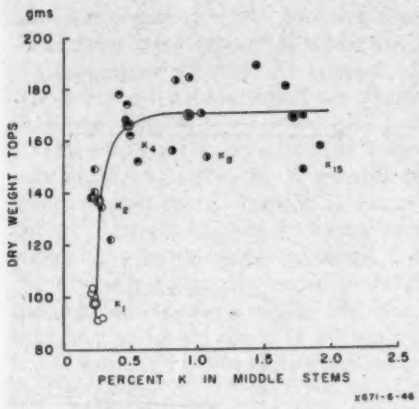


Fig. 3. Relation of yield to K content of middle stems of alfalfa grown in nutrient culture. K_1, K_2.....K_{15} refer to initial concentration of potassium expressed as milliequivalents K per liter.

in Figure 3. Plants were harvested at early blossom stage.

The curve shown here is composed of two parts—a vertical arm showing a rapid increase in yield with little change in K content as the supply of potassium was increased, and a nearly horizontal arm showing no further change in yield but a rapid increase in K content at higher levels of potassium in the nutrient solutions.

The breaking point of this curve or the "critical level" is at or near .75% K, values above representing luxury uptake, and values below representing varying degrees of deficiency.

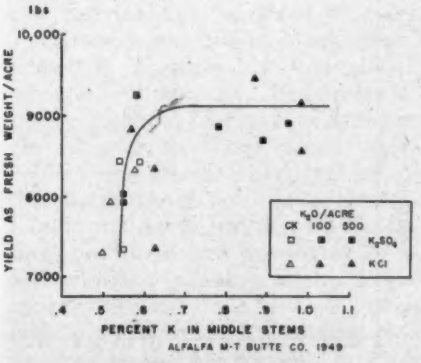


Fig. 4. Relation of yield of alfalfa to K content of middle stems in 1949 rate—source field experiment.

A comparison of field data with that derived from greenhouse studies may be of help in evaluating tissue analysis of alfalfa as a diagnostic tool. Figure 4 shows the relationship between yield and K content of middle stems taken from the September cutting of the first rate-source experiment.

It will be noted that the curve is similar in form to that derived from greenhouse water culture methods. The "critical level" is indicated as break in the curve at about .65% K, with no further increase in yield, but a large increase in K content at the 500-pound rate of K_2O applied. In this curve, points from all three replications, both with K_2SO_4 and K Cl are plotted. It is significant that yields show a better relationship to K content than to fertilizer treatments.

A second example of the relationship of yield to potassium content of alfalfa is shown in Figure 5. Here the yield data from the 1950 and 1951 field experiments are plotted against the K concentration of the middle stems. These experiments represent response to K under conditions of acute deficiency. In 1950, a set of samples of entire tops was taken for analysis and comparison with corresponding middle stem samples.

Middle stem data from both the 1950 and the 1951 field tests fall along the same curve. The break at the "critical level" is less sharp than in the greenhouse experiment, but appears to be at about .70% K.

The K concentration of the whole tops gives a good curve, similar to that obtained in relating middle stems to yield but breaking less sharply. The "critical level" appears to be at or near 1% K in the whole top.

The same curves in Figure 5 illustrate what may be expected in improved yields when K-deficient alfalfa is fertilized and no other deficiency is induced. If a field is acutely deficient, with middle stems containing .3% K, yields may be doubled, if cultural

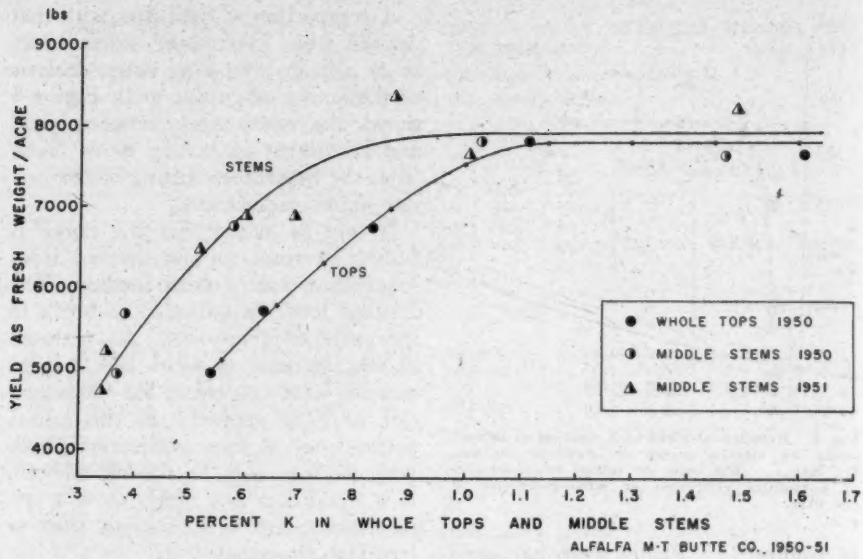


Fig. 5. Relation of yield of alfalfa to K content of both tops and middle stems in 1950 and 1951 field experiments.

practices and climatic conditions remain essentially the same. If the deficiency is less severe and middle stem values contain .4% K, a 35% increase might be expected. If the field were only mildly deficient, with few symptoms and K value at .6% K, then an increase of only 7 to 10% in yield would be all that might be expected.

Similar prognosis might be made from whole top samples. Analysis of the whole tops shown on the color cover reveals 1.5% K in normal plant, .94% K with mild deficiency, .71% K for severe deficiency, and .48% in the acutely deficient plants.

Since the K content of the whole top is related to response to potassium, it may be of interest to see just how well it is related to the composition of the middle stems. From the Butte County tests, comparison of 15 pairs of samples may be made. In the Sacramento County alfalfa nutrient survey, 48 pairs of duplicated samples were taken, one group of 48 were fractioned

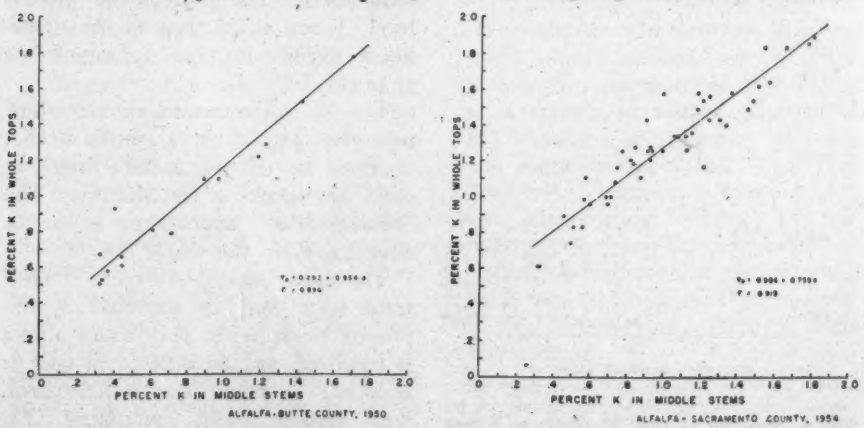

PERCENT K IN WHOLE TOPS
PERCENT K IN MIDDLE STEMS
ALFALFA - BUTTE COUNTY, 1950
PERCENT K IN WHOLE TOPS
PERCENT K IN MIDDLE STEMS
ALFALFA - SACRAMENTO COUNTY, 1954

Fig. 6. Comparison of potassium content of whole tops and middle stems of alfalfa — (left, Butte County, 1950; right, Sacramento County, 1954).

to middle stems, while the duplicate 48 samples were ground as whole tops.

Comparison of the K content of whole top and middle stems are shown in Figure 6.

There appears to be a definite linear relationship between the K content of the two plant parts. At high K values, the K content of middle stems and whole tops is practically identical. In the deficient range, the per cent K of the middle stems is clearly less than that of the whole top. If a "critical level" value of middle stems were taken as the range, at .65 to .75% K, the entire top would show a critical value of 1.0 to 1.1% K. This is about where the "critical level" occurs in the curve of the whole plant, as shown in Figures 3, 4, and 5.

The analysis of whole tops offers some advantages as a part for analysis in using tissue analysis as a diagnostic tool. Taking the samples is easier and simplier, although grinding and preparing the extra material is an added problem. Samples of whole tops may also be analyzed for protein and phosphorus content and thus evaluated for use as animal feeds. Such whole top samples, however, have the disadvantage of being likely to mold rapidly in transit and may be less reliable than indicated here if abnormal leaf fall takes place due to mildew or other plant disease condition. Hay samples taken from bales would not be reliable, since considerable leaf shattering and loss usually takes place in the raking and baling processes.

A Few Live Embers

(*From page* 5)

of the probable cost were as erroneous as our own were in 1791.)"

Washington had accepted the presidency of the canal company incorporated by both Maryland and Virginia. Detroit was then the capital of the Indian fur trade. It was thought by Washington and others that a route by waterways could be built to advantage to connect Detroit and Alexandria. Alexandria was 349 miles nearer to Detroit than Montreal, with only two carrying stops of about 40 miles.

Watson found one of Washington's letters to Marquis de Chastellieux, wherein he wrote: "In 1783 I proceeded up the Mohawk river to Fort Schuyler, crossed over to Wood Creek which empties into Oneida Lake, and affords the water connection with Ontario. I could not but be struck with the immense diffusion and importance of it, and with the goodness of that Providence which has dealt his favors to us with so profuse a hand. Would to God we may have the wisdom to carry it out."

Continuing the report of his domestic visit with Washington, Watson says:

"He pressed me to settle on the borders of the Potomac, and at his insistence I proceeded to examine the falls, traveling 22 miles from Alexandria, on the south shore of the river.

"To contemplate such a man in the bosom of his family, I shall always consider as one of my greatest privileges. I found him perfectly amiable in his domestic circle. He was revered and loved by all around him; agreeable socially without ostentation; delighting in anecdote and adventures; unassuming; and with his domestic arrangements harmonized into system.

"His servants appeared to watch his eye and anticipate his wishes. A look was equivalent to an order. His servant, Billy, faithful companion of his military career throughout the war, was always at his elbow; and smiling, contented, animated.

"The first evening I spent with him we sat a full hour by ourselves at table, without the least interruption after all the family had retired to rest. I was afflicted with a hard cold and incessant

coughing, owing to the extremes of winter travel. He pressed me to take something to relieve my cough, which I declined, not wishing to trouble the family at such a late hour.

"I was conducted to my chamber by Billy. As usual, after getting into a cold bed, my coughing increased. After some time had elapsed, the door of my room was suddenly opened; I drew aside the curtain; and beheld to my astonishment, standing before me at the bedside, this great man, holding a candle in one hand and a bowl of hot tea in the other.

"I was really mortified and distressed that he should have thus condescended. This little incident in common life with a common man would hardly be noticed; but considering a warrior, accustomed to blood and carnage, and human woes in every shape, and as a trait of Washington's virtues, it deserves to be recorded.

"In my journal of March 1778, on a former trip from Georgia and being at Alexandria, I wrote as follows:

"I saw at Mt. Vernon a magnificent tomb in my imagination, in which were deposited the ashes of the immortal Washington, now in his glory (then 46 years old) and then as eagerly viewed by the travelers as Pompey's pillar or the ruins of Rome. Americans will justly boast in standing by the tomb of Washington: Here lie the ashes of one whose life was comparatively without spot or blemish, and on whom the Great Fountain of Virtue was pleased to bestow as much purity as imperfect human nature is capable of receiving; whose example will be held up to remote ages as a model for the human race."

No more prophetic words could have been penned over 21 years before General Washington died. Tons of flowers and wreaths of tribute have been laid against those iron bars before the white marble tomb in all the years that have passed away; and many of the world's potentates, statesmen, and ordinary good citizens have done just what Watson predicted with his usual foresight and imagination.

With those records of a pleasant past disposed of, let's see what events were casting shadows of big things to come just about 100 years ago. That was the year of our first land-grant college of instruction in agriculture. But other references are handy to prove that Michigan was not alone a century ago in striving to set up such institutions.

A YEAR Book of Agriculture was published regularly by Childs & Peterson, 124 Arch street, Philadelphia. The editor and fact gatherer for this important work was David A. Wells, A. M. We dip into some of the reports given in the 1856 Year Book by Mr. Wells, who later was a chemist at a Midwest college:

"Never before in our history has agriculture in all its varied departments presented so prosperous and promising a condition as at the close of 1855," wrote Mr. Wells.

Careful estimates of gathered crops for 1855 were added as best they could for that day and era. Indian corn, ten hundred million bushels; wheat, 180 million bushels; oats, 400 million bushels; rye and other grains 100 million bushels; and cotton, a smaller than usual crop, 3,200,000 bales, or about 1,280,000,000 pounds.

Many good beginnings in education were listed. Dr. Daniel Lee, former editor of the Genessee Farmer and Southern Cultivator, was made president of agriculture at the University of Georgia, with funds in the will of Dr. William Terrell. Amherst College in Massachusetts had offered courses in agriculture, under the supervision of Professor J. N. Nash, editor of the Valley Farmer, and Rev. Dr. Hitchcock, former president of Amherst College.

Back in 1852 a charter for an agricultural college was granted by the New York legislature, mostly at the request of Hon. John Delafield, Fayette, Seneca county. His sudden demise halted work begun on Delafield's farm, where it was to be located. The trustees consented it to be removed to the Town of Ovid, Seneca county, and so in August 1855, Ovid township supervisors pledged the sum of $10,000; the county put up $30,000 so that work might continue.

Further back, in 1844, an agricultural department was set up at Oberlin College, Oberlin, Ohio. A course of lectures were then begun. At the 1855 session of the Ohio legislature, they incorporated the Ohio Agricultural College, and Cleveland was the site chosen. The transfer of Oberlin's lecture course to the main college was ordered. Slated to begin in December 1855, the president was Harvest Rice, with a faculty composed of J. P. Kirtland, S. St. John, N. S. Townsend, J. Dascomb, and J. H. Fairchild. A reading room supplied with farm journals was offered. The tuition was set at only $40 for the course. Mr. Harvest Rice surely had a favorable name with which to begin agricultural teaching. Wish we knew more about him.

The Pennsylvania legislature in 1855 incorporated a new "farmers' high school" and it was organized at Harrisburg in June. Trustees could select a good location embracing between 200 and 2,000 acres and choose a principal and other officers of suitable practical and scientific attainments. The State Agricultural Society was allowed to provide a sum not exceeding $10,000 and then follow with annual donations as far as their income permitted.

The Union Agricultural Society of Virginia and North Carolina raised $20,000 for a model experimental farm near Petersburg, Virginia. Operations had begun there in 1855, directed by Mr. Nichol, one of the editors of Southern Farmer. Suitable offices, buildings, and fences were finished in 1855, the farm was laid out, trees planted, and some progress made in certain field trials. From extracts published in Southern Farmer, the station treated oats with 200 pounds of Peruvian guano, with 70 bushels per acre yield. DeBerg's superphosphate made 54 bushels of oats at 250 pounds applied per acre. Bone dust caused a 53-bushel return per acre, and an acre without any manure yielded only 35 bushels.

THE National Agricultural Society met at Washington, D. C., in 1855. One of the speakers was George Washington Custis, a former ward of General Washington, and then owner of Arlington Farms, which then boasted 5,000 acres—now completely covered with apartment houses, trading centers, fast highways, and military installations. Mr. Custis told the meeting that for several years he was obliged to mortgage the estate so as to meet the expenses of his family and the slaves he maintained. He had a soil analysis made finally with a view to ascertaining its deficiencies.

"Now," said Mr. Custis, "I can say that instead of mortgaging my estate I am continually lessening the mortgage debt. This year I have 10,000 bushels of wheat for the miller, while, until the soil analyses were made and deficiences corrected, I was never able to sell a single bushel of wheat above that used for the household and the farm hands." Thus spake the father-in-law of General Robert E. Lee, who, it so happens had to take up the farm game there when Custis played out—and had a tough time doing it, as Freeman's notable book will tell you.

So we have come to the end of this string. We have poked at some old embers on the hearth of time, and maybe we can detect a few bright sparks still left over from the teaching of agriculture as visionaries planned it five score years ago.

FREE LOAN OF EDUCATIONAL FILMS

The American Potash Institute will be pleased to loan to educational organizations, agricultural advisory groups, responsible farm associations, and members of the fertilizer trade the motion pictures listed below. This service is free except for shipping charges.

FILMS (ALL 16 MM. AND IN COLOR)

The Plant Speaks Thru Deficiency Symptoms (Sound, running time 25 min. on 800-ft. reel.)

The Plant Speaks, Soil Tests Tell Us Why (Sound, running time 10 min. on 400-ft. reel.)

The plant Speaks Thru Tissue Tests (Sound, running time 14 min. on 400-ft. reel.)

The plant Speaks Thru Leaf Analysis (Sound, running time 18 min. on 800-ft. reel.)

Save That Soil (Sound, running time 28 min. on 1200-ft. reel.)

Borax From Desert to Farm (Sound, running time 25 min. on 1200-ft. reel.)

Potash Production in America (Sound, running time 25 min. on 800-ft. reel.)

In the Clover (Sound, running time 25 min. on 800-ft. reel.)

In Canada: The Plant Speaks Thru Deficiency Symptoms
The Plant Speaks, Soil Tests Tell Us Why
The Plant Speaks Thru Tissue Tests
The Plant Speaks Thru Leaf Analysis
Borax From Desert to Farm
Potash Production in America

DISTRIBUTORS

Northeast: Educational Film Library, Syracuse University, Syracuse 10, N. Y.

Southeast: Vocational Film Library, Department of Agricultural Education North Carolina State College, Raleigh, North Carolina.

Lower Mississippi Valley and Southwest: Bureau of Film Service, Department of Educational Extension, Oklahoma A & M College, Stillwater, Oklahoma.

Midwest: Visual Aid Service, University Extension, University of Illinois, Champaign, Illinois.

West: Department of Visual Education, University of California, Berkeley 4, California.

Department of Visual Education, University of California Extension, 405 Hilgard Ave., Los Angeles 24, California.

Department of Visual Instruction, Oregon State College, Corvallis, Oregon.

Bureau of Visual Teaching, State College of Washington, Pullman, Washington.

Canada: National Film Board, Ottawa, Ontario.

For the Province of Ontario: Distribution Services, Ontario Agricultural College, Guelph, Ontario.

IMPORTANT

Requests should be made well in advance and should include information as to group before which the film is to be shown, date of exhibition (alternative dates if possible), and period of loan.

Request bookings from your nearest distributor.

AVAILABLE LITERATURE

The following literature on the use of fertilizers in profitable soil and crop management is available for distribution. We shall be glad to send these upon request and in reasonable amounts as long as our supply lasts.

Reprints

28-12-45 Better Corn (Midwest) (Circular)
F-3-40 When Fertilizing, Consider Plant-food Content of Crops
S-5-40 What is the Matter with Your Soil?
Y-5-43 Value & Limitations of Methods of Diagnosing Plant Nutrient Needs
A-1-44 What's in That Fertilizer Bag?
P-3-45 Balanced Fertility in the Orchard
Z-5-45 Alfalfa—The Aristocrat
OO-8-45 Potash Fertilizers Are Needed on Many Midwestern Farms
ZZ-11-45 First Things First in Soil Fertility
T-4-46 Potash Losses on the Dairy Farm
Y-5-46 Learn Hunger Signs of Crops
TT-11-47 How Different Plant Nutrients Influence Plant Growth
VV-11-47 Are Your Pasture Conscious?
X-6-48 Applying Fertilizers in Solution
AA-6-48 The Chemical Composition of Agricultural Potash Salts
GG-10-48 Starved Plants Show Their Hunger
SS-12-49 Fertilizing Vegetable Crops
BB-8-50 Trends in Soil Management of Peach Orchards
X-8-51 Orchard Fertilization Ground and Foliage
BB-10-51 Healthy Plants Must Be Well Nourished
II-12-51 Pasture Improvement With 10-10-10 Fertilizer
KK-12-51 Potassium in Animal Nutrition
A-1-52 Research Points the Way to Higher Levels of Peanut Production
Y-10-52 The Nutrition of Muck Crops
CC-12-52 The Leaf Analysis Approach to Crop Nutrition
I-2-53 Sericea Is a Good Drought Crop
J-3-53 Balanced Nutrition Improves Winter Wheat Root Survival
K-3-53 Kudzu Keeps Growing During Droughts
N-4-53 Coastal Bermuda—A Triple-threat Grass on the Cattleman's Team
P-4-53 Learning How to Make Profits from Sweet Potatoes
T-5-53 Trefoil Is Different
W-6-53 The Development of the American Potash Industry
DD-10-53 Sampling Soils for Chemical Tests
II-11-53 The Importance of Legumes in Dairy Pastures
JJ-11-53 Boron—Importance to Crops
MM-12-53 White Birch Helps Restore Potash-Deficient Forest Soils
K-2-54 Soil and Plant Analysis Increase Fertilizer Efficiency
R-3-54 Soil Fertility (Basis for High Crop Production)
U-4-54 Nutrient Balance Affects Corn Yield and Stalk Strength
CC-6-54 Fertility Increases Efficiency of Soil Moisture
EE-8-54 Red Apples Require Balanced Nutrition
FF-8-54 Apply Fertilizers in Fall For Old Alfalfa, Grass Pasture and Timothy-Brome Fields
GG-8-54 Eect of Boron on Beets and Crops Which Follow
JJ-10-54 Principles Involved in Soil Testing
LL-10-54 Relation of Fertilizer to Quality and Yield of Flue-cured Tobacco
MM-10-54 Longer Life for Ladino
SS-11-54 Foliar Application of Plant Nutrients to Vegetable Crops
VV-12-54 Potassium Affects Growth of Stocks
YY-12-54 Physical Condition of the Soil Affects Fertilizer Utilization
A-1-55 Potash-Deficiency Symptoms
C-1-55 Summary of Ten Years' Work with Complete Fertilizers on Sugar Cane
D-1-55 Nitrogen Use Accentuates Need for Minerals
E-1-55 Guides to the Management of Illinois Soils
F-1-55 The Soil Profile's Contribution to Plant Growth
G-2-55 Seven Steps to Good Cotton
H-2-55 Apparent Fertility Trends in Western Irrigated Soils
I-2-55 Shortages of Potash Limit Grape Yields
J-2-55 Fruit Fertilization in New Jersey
L-3-55 Soybean Production in the Southern States
M-3-55 Possibilities and Limitations of Irrigation in the Southeast
N-3-55 The Pacemaker Club Grows More Corn
P-3-55 N-P-K for Deciduous Fruit Trees
Q-3-55 Soil Testing Moves Ahead in Arkansas
R-4-55 Potash Prevents "Curl Leaf" of Sour Cherries
S-4-55 Greener Pastures Mean Better Living
T-4-55 Leaf Analysis Reveals Potash Need in Southern Oregon
U-4-55 Fertilizer Recommendations—Burley Tobacco
V-4-55 Planned Nutrition for Canning Tomatoes
W-5-55 The Production of Sugar Beets on Organic Soils
X-5-55 What Is Happening to Our Citrus Soils?
Y-5-55 Pasture Improvement Through Renovation
Z-5-55 Azalea Fertilization
AA-5-55 Soil Improvement Pays in Large Figures
BB-8-55 Residual Fertility Insures Alfalfa After Drouth
CC-8-55 Plan Before You Fertilize
DD-8-55 A Good Summer Grass Team
EE-10-55 Fertilizing For Better Apples
FF-10-55 Sod Seeding Improves Pastures
GG-10-55 Improved Water-disposal Systems
HH-10-55 Fertilizers Will Cut Production Costs

THE AMERICAN POTASH INSTITUTE

1102 16th STREET, N. W. WASHINGTON 6, D. C.

The entire community was striving to convert old Uncle Ab.

One day, a long-time friend tackled the problem. "Ab," he questioned, "don't it soften your heart to know the Lord loves you?"

Uncle Ab snorted. "Do you aim to tell me," he scoffed, "that the Lord loves me when he ain't never knowed me?"

The old friend thought a moment, then said sadly, "Ab, it's a heap easier for the Lord to love you without knowin' you than if he knowed you like I do."

* * *

Parson: "Goodbye and God bless you. Be careful that the rowdies in town don't play tricks on you."

Newlyweds: "Don't worry, Parson, they won't catch us napping."

* * *

A golfer who was none too good was playing a particularly bad game on this day.

Golfer—"Good heavens! I'm sure that there can't be any worse golfers than I."

Caddy—"Oh, I wouldn't say that, sir. I'm sure there must be worse players than you—it's just that they don't play."

* * *

Overheard: "We left our son alone tonight. He's at the age now where we don't trust him with a baby-sitter."

Two members of the Eighth Air Force, awaiting redeployment in England, were passing the time by wandering through a country churchyard near their station and reading some of the quaint headstones:

First: "Look here, here's a dandy, 'Sacred to Thomas Sitter, A Lawyer, and An Honest Man'."

Second: "What did they want to put all three in one grave for?"

* * *

Have you heard the story of the middle-aged Texan who went to the psychiatrist? "Doc," he began, "I shore need yore help. I'm in a bad way. I been a Texan all my life, and suddenly I just don't give a damn!"

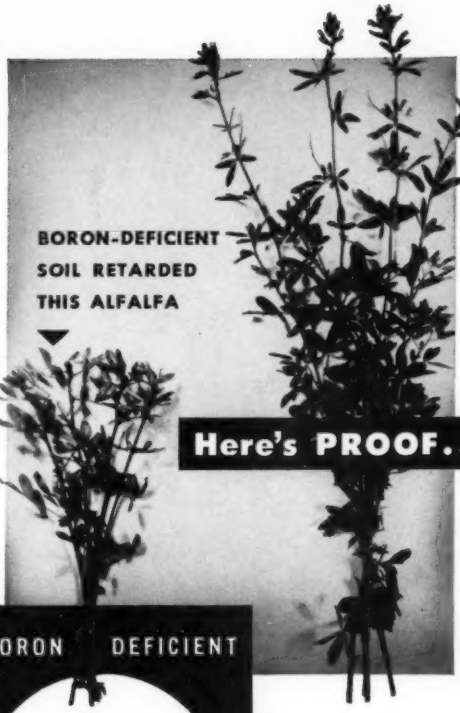
* * *

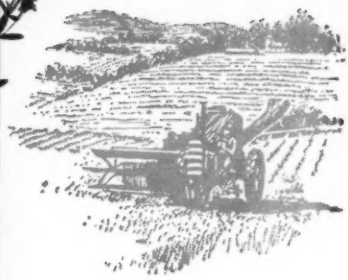
"Mummy," said little Brian, "Percy doesn't know how to swim because his mother won't let him go near the water." "Well, Percy's a good boy," replied mummy. "Yes," answered Brian thoughtfully, "He'll go to Heaven the first time he falls in."

* * *

"And what is your reason for wishing to marry my daughter?" asked the father.

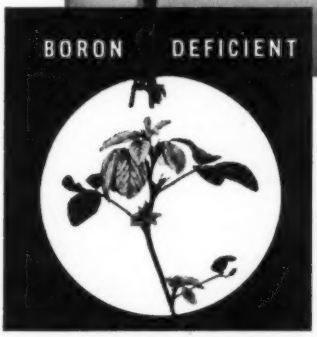
Puzzled, the young man scratched his head, pondered a second, then answered: "I have no reason. I'm in love."





Here's PROOF... $1 to $2 spent on

Fertilizer Borate (HIGH GRADE)



. . . . Look for These Symptoms in Alfalfa: Lack of boron causes plants to become puny and dwarfed. Look for yellow or reddened top leaves, stunted, with growing tips rosetted. See close-up photo.

can give you an extra ton of Alfalfa hay per acre...

See for yourself what Fertilizer Borate, with its high boron content, meant to this alfalfa field. Boron, so vital to alfalfa, is also required by other field crops such as clover, sweet corn, tobacco... and most vegetable and fruit crops. This year, invest a few extra pennies per acre in Fertilizer Borate... the low-cost fertilizer grade of borax... to grow better crops!

● ***Fertilizer Manufacturers*— *Here's Borax at the Lowest Cost per Unit... It's Fertilizer Borate-High Grade!***

This sodium borate concentrate, developed especially for the fertilizer trade, has higher analysis... approximately 121% borax equivalent. Choice of fine or coarse mesh.

Write for Bulletin PF-3!

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